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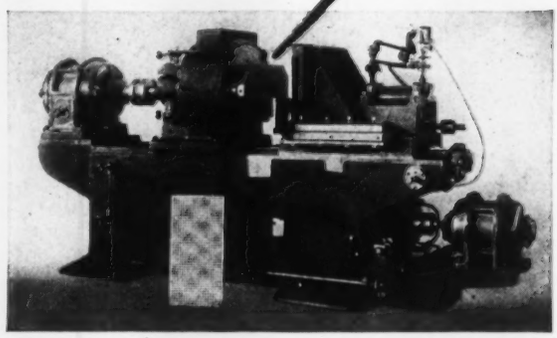

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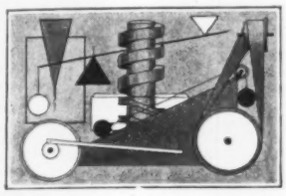
ENGINEERING–PRODUCTION–SALES

Volume 3 | April, 1931 | Number 4



Next MONTH

EMPLOYMENT of compressed air in machinery, though basically one of the earlier methods of obtaining motion or applying force, is a subject of prime importance in these days of economical production. Any sound method of reducing operating costs necessarily must be considered fully by the engineer in charge of design.

A comprehensive article is scheduled for the May issue covering various phases of the use of compressed air devices and describing some of the mechanisms involved. Subsequent articles will treat other aspects of the subject. It is believed this series will serve a distinctly useful purpose.

L. E. Jermy.

Managing Editor

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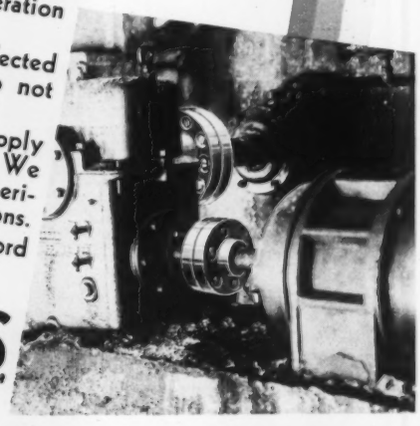

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Itemized Index, April, 1931

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PATENTS are of fundamental importance in the field of Machine Design. Remove the protection afforded by patents and much of the supremacy of the United States in the development of machinery would be dissipated in a brief period of time.

The great mass of patents granted by the Patent Office is gone over each month by the editors of Machine Design and those covering machines, parts and materials pertaining to design are selected and reviewed for the benefit of designing engineers. In this issue you'll find the patent section on pages 66 and 68.

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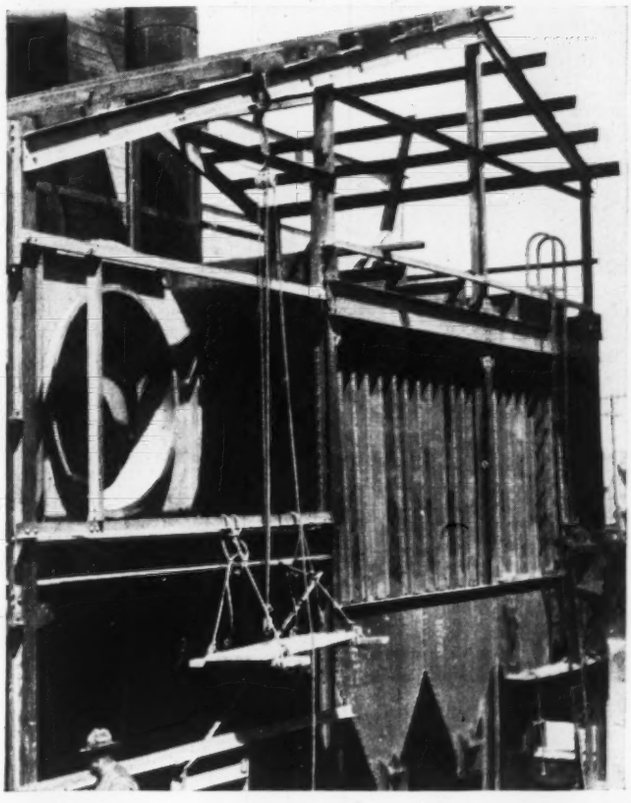

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We are privileged to quote from a letter received from Mr. Hudson H. Bubar, General Manager of Dust Recovery Inc., confirming his experience with Dardelet bolts and nuts:

"These bolts are used in the erection of dust collecting equipment in various types of industries. The collectors consist generally of large rectangular housings varying in sizes from 10' x 12' x 16' up to 16' x 24' x 60'. The inside of these housings is closely packed with series of vertical veins the purpose of which is to precipitate the dust. These veins are bolted to supports at the top and at the bottom. They are also bolted to floating bars which in turn carry perforated plate.

"All of the internal collecting elements are periodically vibrated by a mechanical rapping system. This necessitated a type of bolt, the nut on which would not work loose. We first tried the standard type of machine bolts with lock washers, but later were compelled to disregard the lock washers because of construction conditions and cost, using the standard bolt and after the nut had been drawn up tightly, checking the thread with a cold chisel.

"As a large number of these jobs necessitate the employment of union labor varying in cost from $1.62½ to $2.45 per hour, this additional work resulted in a considerable increase in the cost of erection. Through the use of Dardelet bolts we experience even better results than were previously obtained through the use of the standard bolt, and a very material reduction in erection cost due to the fact that the threads do not have to be checked. Just how much this saving will amount to we can not at the present time definitely state. We feel, however, that the saving in erection equals at least one-half the total cost of all bolts used."

CALENDAR OF MEETINGS AND EXPOSITIONS

April 13-17—American Society of Mechanical Engineers. A co-ordinated program featuring management, maintenance and materials handling to be held in Public Auditorium, Cleveland. Technical sessions will include drafting room management and standardization in material handling, April 14, and the design of handling equipment, April 15. Participating organizations include American Management association, and Society of Industrial Engineers. Advanced designs in handling equipment are to be exhibited. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary.

April 13-18—Second National Industrial Equipment Exposition. In conjunction with M-M-M congress, exhibits will be displayed in Public Auditorium, Cleveland. These exhibits will be confined to equipment of service and use to the management, maintenance and materials handling divisions of industrial plants. Modern production demands newer things, and the latest developments of designers and engineers will be on display. G. E. Pfisterer, 308 West Washington street, Chicago, is secretary.

April 13-18—American Oil Burner association. Latest developments in the burner and accessory fields will be exhibited at the eighth annual meeting and oil burner show to be held in Benjamin Franklin hotel, Philadelphia. An engineering session is to be held Saturday, April 18, at which time the design improvements in the burners will be discussed. Harry F. Tapp, 342 Madison avenue, New York, is executive secretary.

April 20-23—American Society of Mechanical Engineers. Semiannual meeting at Hotel Tutwiler, Birmingham, Ala., will inspect southern industrial plants and discuss paper and pulp industry, centrifugal production of pipe, mono-cast pipe, hydraulic laboratory, natural gas transmission, blast furnace power plants, industrial plant location, and air transport. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary.

April 22-24—American Welding Society. Annual meeting in New York. M. M. Kelly, 33 West Thirty-ninth street, New York, is secretary of the society.

April 23-24—Association of Manufacturers of Wood Working Machinery. Meeting in New York. F. A. Collinge, 111 West Washington street, Chicago, is secretary.

April 27-28—American Supply and Machinery Manufacturers Association. Annual meeting in Wardman Park hotel, Washington. R. Kennedy Hanson, 916 Clark building, Pittsburgh, is secretary.

May 4-8—American Foundrymens' association. Technical sessions scheduled for the 1931 meeting and exhibition in Stevens hotel, Chicago, will include discussions of steel, malleable, gray iron and nonferrous founding, production costs, apprentice training, and pattern production. C. E. Adams, 222 West Adams street, Chicago, is secretary.

May 4-9—Exposition of Chemical Industries. Six new pastel colors on which it is reported that they are capable of being molded under conditions similar to molding conditions of standard compounds will be one of the prominent exhibits at the thirteenth biennial exposition in Grand Central Palace, New York.

May 6-8—American Society of Refrigerating Engineers. Spring meeting at Hotel President, Kansas City, Mo. David L. Fiske, 37 West Thirty-ninth street, New York, is secretary of the organization.

May 7-9—American Gear Manufacturers' Association. Papers to be presented at the annual spring meeting at Hotel Statler, Buffalo, include: "The Strength and Durability of Spur Gears," by Professor Earl Buckingham, Massachusetts Institute of Technology; "Contact Stresses in Gears," by R. V. Baud, Westinghouse Electric & Mfg. Co.; and "Non-Metallics," by C. W. Mansur, General Electric Co., West Lynn, Mass. T. W. Owen, 3608 Euclid avenue, Cleveland, is secretary.

May 11-15—American Mining Congress. Eighth annual convention to be held at Cincinnati. At the same time a national exposition of mining machinery and equipment will be conducted. J. F. Callbreath, 841 Munsey building, Washington, is secretary.

May 12-14—American Society of Mechanical Engineers. National Aeronautic meeting, Baltimore. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary.

June 15-18—American Society of Mechanical Engineers. Fourth National Oil and Gas Power meeting to be held at the University of Wisconsin at Madison. E. J. Kates, secretary of the division, has announced that the technical program of the meeting would be arranged by Julius Kuttner, editor of *Diesel Power*, in co-operation with Professors G. L. Larson and B. G. Elliott of the university.

MACHINE DESIGN
THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO
April, 1931 Vol. 3—No. 4

New Process Necessitates Design of Special Machine

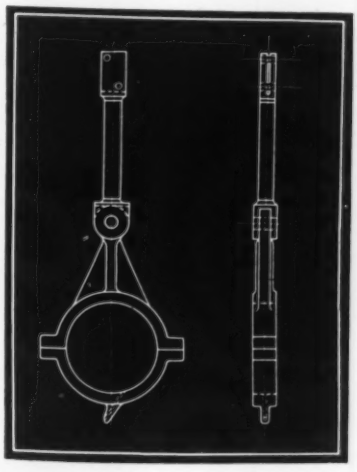
By D. M. Fincke
Booth Engineering Co. Ltd., New York

IN THE various food industries there probably are more types of automatic and so-called "labor saving" machines required than in the average manufacturing business. This is due to the special processes encountered and to the need for special machines for such processes. Rarely can standard machines be used to advantage. The present day bakery, dairy, candy factory, or canning plant each has its individual problems, and these are subject to constant change just as the appetite of the public changes and demands variety and new appeal in food products.

Speed in designing and perfecting new machines is essential. Naturally, time-tried and proven ideas are used whenever possible but occasionally the need arises for a bold departure from the conventional process. In these cases the ingenuity of the designer is taxed to the utmost.

The market for any one particular type of a machine may not be great. It may be as few as ten machines for a total requirement, or the saturation figure may run as high as five thousand machines. Rarely is it higher. Thus a great deal of research and experimental work cannot be done. The designer must hit the mark with his first attempt and only minor changes can be afforded.

The following is a discussion of just such a problem and how it was met. Undoubtedly the principles involved can be used to advantage



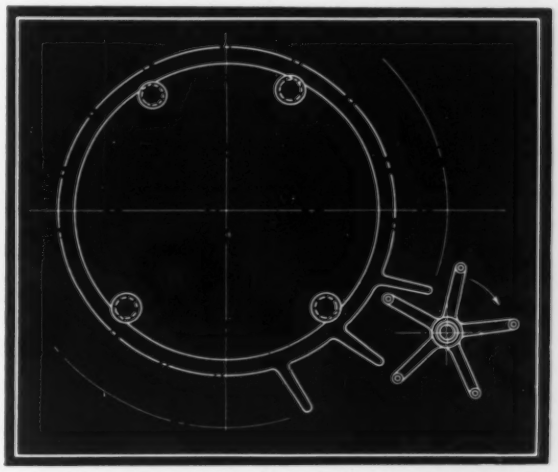


Fig. 1 — (Left) — Connecting rod assembly. The knife is hooked at upper end on to pins passing through holes shown. Fig. 2 — (Right) — Floating rings are mounted on four grooved rollers and driven at varying speed by star drive

in other machines. Several novel ideas used by the designer are explained in detail.

The machine in question is for slicing bread in the baking industry. Sliced bread was introduced by a progressive baker in the Middle West and became popular overnight. In fact, it became so popular that slicing machines soon were at a premium and were being manufactured and delivered almost before the paint was dry! But both the process and the machines were extremely crude and an urgent need became apparent for improved models.

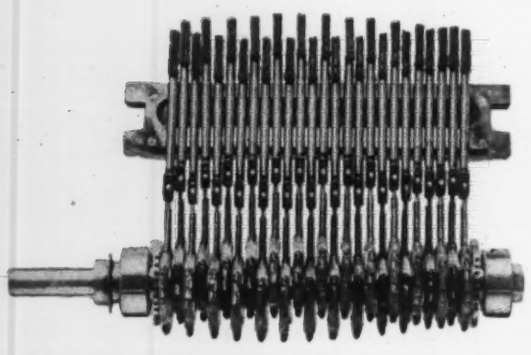


Fig. 3—Assembly of connecting rods and crankshaft. Tappets are guided in the bronze upper half of crankcase, which is split

Three main functions are required of a slicing machine. The bread must be conveyed to the knives, sliced and delivered automatically into the wrapping machine so that a continuous process will result with minimum labor and maximum speed. This fact had not been recognized by previous designers who had one machine merely for slicing the bread which then was transferred by hand into the wrapping machine. The maximum speed of the first machines also was much less than the wrapping machines, resulting in delayed operations. A poorer quality product was obtained due to the long time interval between slicing and wrapping so that the bread, especially when sliced, had a tendency to dry out before it was wrapped. The problems that faced the designer were a high-speed method of slicing, positive feed and direct connection to the wrapping machine.

Unusual Design Is Developed

The machine to be described, known as the Hartman Bread Slicer, was designed by a California engineer with an imagination and nerve to do the unusual. Californians usually do not hesitate to depart from conventional practice if it appears that the result will be beneficial. This particular machine has proved to be outstanding for its purpose and within the past year has been adopted as standard by the country's leading bakers.

Iron castings of good quality are difficult to obtain on the Pacific Coast. Since pig iron has to be transported from the East, the tendency in foundries is to use a higher percentage of scrap than is customary in other parts of the country. This being the case, the frame of the machine was made of three-inch angle iron, welded. The various parts of the frame are cut to length, mitered where necessary, placed in a jig and welded at all joints and braces to form a rigid structure. A lighter weight frame of greater strength than cast iron is the result, and this is a tremendous advantage for shipping to eastern cities. Freight rates are lower on account of the lighter weight, which advantage can be passed on to the purchaser. Due to the strength of the welded steel frame there has not been a single case of a machine damaged in transit.

While angle iron frames often are used in the East for experimental or "pilot" machines, specifications usually are changed to cast-iron frames when the machine is put into production. With the methods used in the production of this machine, the cost of the angle iron frame is not greater than if cast iron had been used. After the frame itself has been welded and removed from the assembly jig, other jigs are used for drilling all holes for bearing brackets and additional parts to be assembled to the main frame.

As stated previously, a positive conveying machine was required to take the loaves through the knives. This was accomplished by a canvas conveyor belt on which the bread is placed by one operator, as shown in Fig. 5. From the belt, the loaves are delivered to a series of rings similar to a ferris wheel (see Fig. 2) by means of an intermittently operating spindle which transfers the loaf from the end of the belt and places it upside down in the pockets formed by fingers on these rings. The ferris wheel principle, with the loaf upside down, was adopted for two reasons. First, each finger on a ring passes between two adjacent knives, giving positive and continuous delivery of the loaf through the knives. Reciprocating mechanisms thus are eliminated which, due to the greater time required for a reciprocation to take place, would

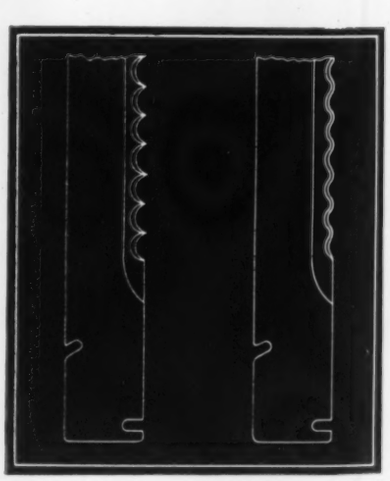


Fig. 4 — Two types of knife cutting edge are shown. The grinding contour depends on the kind of bread to be sliced

have decreased the speed of the machine in loaves per minute sliced. Second, the loaf is fed through the knives upside down so that a cardboard carton or tray can be placed on the bottom of the loaf, immediately after slicing, to keep the slices together and enable its package to be wrapped. Obviously a greater speed is possible where it is not necessary for an operator to pick up a number of slices and place them in a cardboard tray, which had been the practice formally.

Rings Are Mounted on Rollers

The method of mounting these rings and of driving them is unique. Twenty-seven cast aluminum rings each 22 inches inside diameter and 3/16-inch thick are mounted on four grooved rollers running on antifriction bearings carried in outside frame members. The rollers are steel with grooves ¼-inch deep spaced 7/16-inch or ½-inch apart depending upon the thickness of the slice desired. Each ring is free to turn independently of the others as there are no connecting pieces between individual rings. This is necessary so that they can pass between the knives. The rings are driven from the back side of their fingers by two five-armed castings joined by rollers. Thus the mechanism of the star drive and the fingers on the rings is similar to two pinions in mesh. The drive is positive and continuous. The star drive, indicated in Fig. 2, revolves at a uniform speed, but the peripheral speed of the rings varies. Due to the curvature of the back side of the fingers, the roller on the star drive at times moves almost tangently to the fingers, thus producing practically no forward motion in the rings. This is done for the purpose of making the rings hesitate or slow down almost to zero at the instant the knives start cutting the edge of the loaf. As a loaf of bread soon after baking is soft and easily can be crushed it is necessary to start cutting slowly on edge rather than broadside. The rings then accelerate so that the cutting is accomplished quickly and with a minimum amount of crushing.

After the loaf is sliced and a tray placed on it, it is carried around with the rings and transferred to a conveyor in the lower part of the machine which delivers it right-side-up directly into the material feed chain of the wrapping machine shown at the right of Fig. 6. The entire conveyor mechanism including the rings is driven by the wrapping machine to keep the slicing machine always in time with the wrapper. For this purpose a roller chain from a sprocket on one of the main shafts of the wrapping machine drives to a sprocket on the slicer. A faceplate type of safety slipping clutch protects the slicing machine from damage in the event that a foreign object accidentally should be placed in it. A similar clutch protects the wrapping machine.

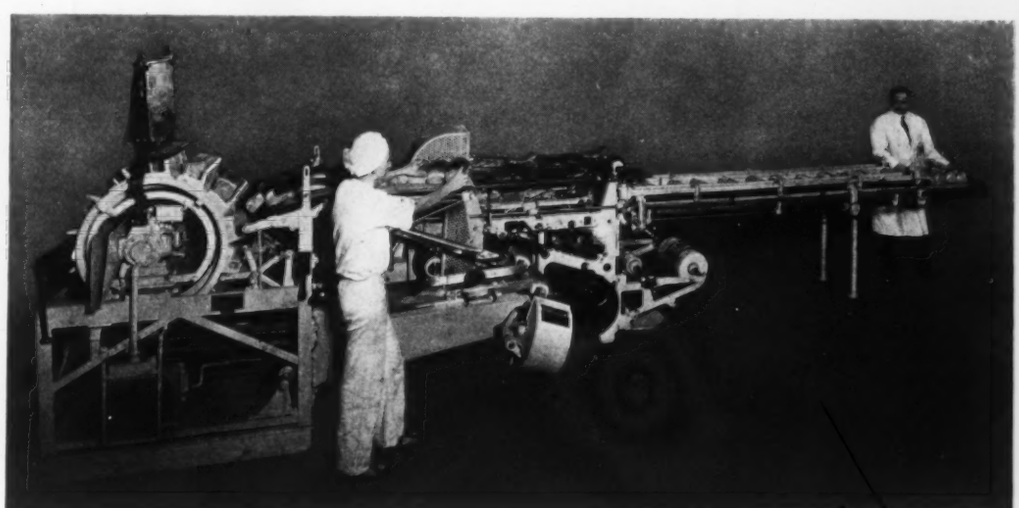


Fig. 5—Bread slicing machine is shown at left of illustration, with operator feeding new loaves. Radiator for oil cooling may be seen, as well as star wheel drive for rings

Undoubtedly the heart of a slicing machine is the knife mechanism. This has to be capable of slicing fifty loaves of bread a minute (which is the full speed of present wrapping machines), with the average loaf being cut into twenty-two slices, the customary household size. One model machine cuts sixty-six slices at one operation but here the number of loaves per minute is reduced to twenty-five. Offhand, a band or circular saw would appear to be the best method of cutting but in practice the reciprocating type of knife is found to be far superior. Since rotary motion could not be used, it was essential that the reciprocating mechanism be capable of high speed and yet be able to operate without excessive vibration.

Care Taken to Obviate Vibration

The knife drive mechanism, Fig. 3, was designed to meet these requirements of high speed and yet be balanced to prevent vibration. A crank or eccentric shaft was made of high carbon steel, turned out of a piece 5 inches in diam-

eter and 18 inches long. Both ends are turned down for ball bearings with provision for a pulley on one end. Twenty-six eccentrics each approximately 2½-inch in diameter with 1-inch throw, 1½-inch wide are turned and ground, and the shaft dynamically balanced. The angle of the advance between eccentrics is determined by dividing the 360 degrees of one complete revolution by twenty-six, the number of the eccentrics to be turned.

The first eccentric is turned at zero degrees and the second at 180 degrees. The third is advanced the desired number of degrees ahead of the first. Thus every other eccentric is on the opposite half of the complete circle from its adjacent eccentric. This is done in order that adjacent knives will travel in opposite directions and the bread will not be crushed. The downward pull on the loaf by a downward traveling knife is offset by the upward pull of adjacent knives.

Fig. 6—After slicing, the loaves are transferred to wrapping machine at right

To each eccentric is assembled a split-cap connecting rod, Fig. 1, made of cast bronze. To the connecting rod a tappet is assembled by a drill rod wrist pin. The tappets are made of hardened and ground steel and guided in vertical motion by a split bronze bearing assembly which is the upper part of the crank case. Two steel pins are assembled to each tappet at the opposite end from the connecting rod. This end is forked and the knife assembled to the tappet through the fork, hooking on to the two steel pins.

Provision Made for Detaching Knives

Tension springs hooked to the upper end of the knife keeps each knife rigid, and the knives may be removed readily without the use of tools by unhooking the springs and tipping them forward so that they can be lifted off the two pins of the tappet.

The entire crankshaft assembly runs in oil. Each connecting rod has a scupper on its cap which is drilled so that oil is forced up around each eccentric, giving adequate lubrication as the scuppers dip in the oil. The oil level is kept below the center line of the crankshaft. It was found that excessive heating of the oil resulted from the twenty-six connecting rods running in side contact with each other, so cooling of the oil was provided. Keeping oil at the best temperature for proper lubrication is most important for any type of machine. This since has been recognized by several automobile manufacturers who have the cooling feature on their 1931 models. Buick is advertising the cooling of the oil in their crankcases with a similar type of mechanism.

In the Hartman slicer a radiator is mounted on one side as shown at the left of Fig. 5. The motor used has an extended shaft on the opposite end from the pulley which carries a gear for driving the oil pump and a fan for forcing air through the radiator. Oil is circulated from the bottom of the radiator to the crankcase by a pump, while the oil returns from the case to the radiator by gravity. With this cooling system the crankcase never becomes unduly heated and the hand can be placed in comfort at all times on it even after the machine has been running for a number of hours.

Totally Enclosed Motor Is Used

The crankshaft is driven by an endless leather belt joining the pulleys on motor and crankshaft. A ball bearing idler is used, and a totally enclosed motor which bread crumbs cannot enter. The speed of the crankshaft is 1800 revolutions per minute. With the 1-inch stroke, this gives a lineal speed to each knife of 3600 inches, or 300 feet, per minute. As 50 loaves of bread are cut per minute there is a knife travel of 6 feet per slice which is ample for quality slicing.

With the crankshaft construction described above, the dead points caused by the knives changing their direction are distributed so that no two occur at the same time. As the length of time of the knife dead point is infinitesimal as compared with the forward travel of the bread, no harm results and the action of cutting is similar to that of continuous rotary motion.

Thus a bread slicing machine was designed to meet all of the requirements of the baker. It runs without vibration due to the balanced crankshaft construction. Its speed equals that of the wrapping machine. A continuous, automatic process is given. Only one additional operator is required over the regular wrapping machine crew and he merely places the cardboard tray on the loaf after it is sliced when so desired. As a further development even this operator has been eliminated as most wrapping machines now are equipped with parts to wrap the sliced bread without the cardboard tray. The slicing machine is equipped with parts to deliver the sliced bread to the wrapping machine either with or without trays, whichever is desired.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

EMPLOYMENT of photoelectric and other electronic equipment is advancing at a rapid pace. So much so that it is difficult to foretell what the next application is likely to be or what eventually will be the result of the development of these devices. Manufacturers of the equipment, while ready to co-operate from an engineering angle in connection with potential uses, necessarily must leave it to the designer and engineer to apply the component parts that are available.

A new application that has just come to light, on which patents are pending, is in connection with the use of photoelectric cells on ready-mixed concrete machines as built by Stephens-Adamson Mfg. Co., Aurora, Ill. The time does not seem to be far off when all concrete for important structures will be proportioned and possibly mixed in central plants particularly as the more accurate means of control will facilitate the sale of concrete on a guaranteed strength basis.

In this new use of the "electric eye," the units are mounted in conjunction with dial scales, as shown in Fig. 2, for weighing the materials constituting the cement mixture. As the aggregates are delivered to one of the weighing hoppers the movement of the dial arrow shows the amount at all times, and when the correct quantity has been delivered the photo cell, interrupted automatically by the dial arrow, instantly shuts off the flow by stopping the feeder. The same procedure is followed on the scale for measuring the prescribed amounts of cement and water required.

Photoelectric equipment is particularly applicable to control of delicate mechanisms such as scales, there being no contact necessary for operation of the actuating mechanism. It seems likely that many other weighing devices shortly will be equipped with a tell-tale bell operated photoelectrically for denoting correct measure, particularly where it is not practical to provide automatic control of the hopper or other type of feed.

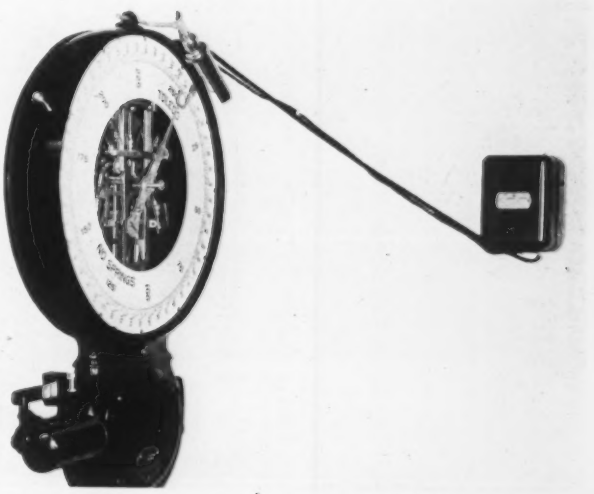


Fig. 2—Employment of photo cell for actuating feed hopper when weight is reached

Fig. 1—A photoelectric unit is operated every second by the swinging pendulum of this master clock. From the electrical impulses obtained, a record is made for checking with naval observatory time

Photo Cell Regulates Clocks

ANOTHER application of photoelectric equipment used in connection with delicate instruments may be found in its employment by the General Electric Co., for recording possible variations of a master timepiece with the government's master clock in the naval observatory at

Washington. The swinging pendulum of the clock operates a beam of light each second and the photo tube is energized and de-energized correspondingly. Electrical impulses thus generated in the photoelectric circuit are amplified and made to operate a relay which actuates a recording pen. The record is checked with a chronograph made from signals received from the naval transmitter at Arlington.

A photoelectric relay also maintains accurate operation of all telechron clocks in the Schenectady plant. The alternating current which operates the clock system is supplied by motor generator set and a master clock governs the system. Three photoelectric relays are used to govern the amount of resistance in the field circuit of the direct current motor of the generator set and thus control the speed of the generator and the frequency of the electrical output.

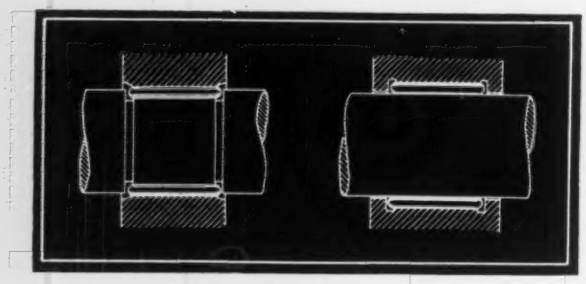


Fig. 3—Needle bearings with recesses for pins in shaft or bearing mounting

A revolving disk operates between the light source and three relays. Slots in the disk are so arranged that, when the frequency of the system is higher than it should be, light falls at regular intervals on a photoelectric tube the relay of which slows down the motor generator set. If the frequency is less than it should be the light passes through another slot in the disk, falls upon another tube and operates a relay which speeds up the generator set. When the frequency is right and the clock system therefore is accurate, the remaining relay is actuated and the generator set allowed to continue operation at the same frequency. Thus the accuracy of the clocks is maintained within a few seconds, from month to month.

Radio Typewriter Is Developed

IN THE Watsonograph, or radio typewriter, two electronic thyratron tubes are used. This new typewriter has been developed by Glenn W. Watson of Detroit, and recently was demonstrated at the Wardell hotel in that city. Figs. 4 and 5 illustrate the sending and receiving ends respectively.

To operate the machine one merely depresses the keys as in ordinary typing, thus sending the impulse to the receiver and also printing the message sent by the sending typewriter. The receiving machine picks up the impulses, one dot for each letter, and prints the message simultaneously with the sending machine. The dots are picked up by an ordinary short wave receiver, passed through an audio frequency amplifier and sent to the thyratron tubes. These tubes have the property of taking a small signal input on the grids and turning it into a large plate current. On receiving the impulses, one of the tubes will light up with a brilliant flare while the other will give off only a dull glow. This is due to the fact that the thyratrons and solenoids are so arranged that the solenoids for alternate letters are connected with different tubes.

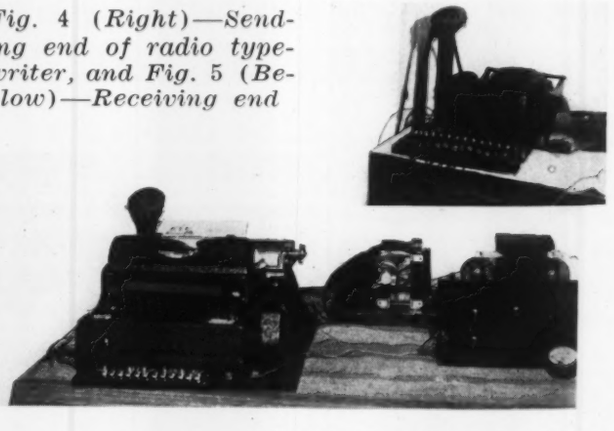
In performance the apparatus is similar to Teletype equipment which transmits by wire and has been in use for some time. There also is another machine being developed at this time by the International Telephone & Telegraph Co., which it is claimed will be capable of transmitting 180,000 words an hour. A laboratory model demonstrated recently transmitted 60 pages of printed matter in an hour, reproducing the type on a continuous strip of photographic paper which was developed almost simultaneously.

Will Needle Bearings Gain Headway?

AN INTERESTING type of bearing that is receiving considerable attention in Europe at this time is the so-called needle bearing. Illustrations of two types are shown in Fig. 3, from which it will be seen that the bearing resembles to some extent the conventional roller bearing but has no cage or guide for the pins.

M. Pitner, engineer of the company manufacturing the bearings, states that they now are being used in the mechanical industries but more particularly in the automobile field. In presenting a paper to the French Society of Automotive Engineers recently, he described the action of the bearing as being similar to a floating bushing in that the needles revolve on their axes only under exceptional circumstances or in starting up under load. After turning for a moment or so, oil

Fig. 4 (Right)—Sending end of radio typewriter, and Fig. 5 (Below)—Receiving end



enters between the needle and raceway to form a film, and due to the large number of rollers between which the load is divided the unit pressure on them is not sufficient to cut through the oil film once it is established.

In certain instances where design considerations make it essential separate raceways can be dispensed with and the needles placed in direct contact with the hardened bore and shaft, as indicated in the illustration. It is of course necessary that these surfaces be sufficiently hard, and nitrided steels are particularly adaptable to this purpose because of their slight distortion in heat treating.

Designs Unique Two-Motor Drive

AN UNUSUAL application of alternating current motors, for driving a mule haulage unit used in placing railroad cars on the cradle of a revolving car dumper, is shown in Fig. 7. Wellman Engineering Co., Cleveland, developed the equipment.

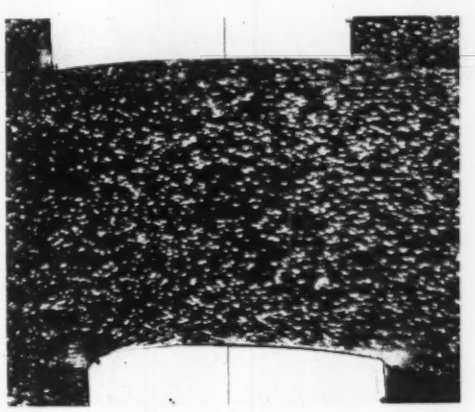


Fig. 6—Sand and talcum powder were used in wind tunnel test of airplane wings

Electrical units consist of a 500 horsepower main motor and an auxiliary two-speed torque motor to give the necessary speed variation. As the car approaches the dumper the mule is slowed down by inserting resistance in the secondary circuit of the main motor, and the torque motor is thrown on the line with a high speed winding. Slowing down and stopping are controlled automatically by limit switches.

Travel Governed by Tunnel Tests

WIND tunnel tests are being employed increasingly in this age of faster travel. For some time Dr. Tietjens, Westinghouse research laboratories, has been testing models of streamline trains as well as those of the present type. He believes that total train resistance can be reduced one-half and wind resistance to one-third for certain kinds of rail equipment at high

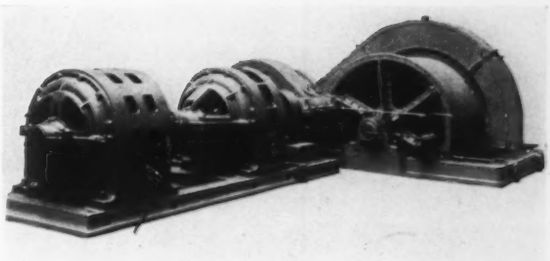


Fig. 7—Two-motor drive used on winding unit of hauling apparatus

speeds. Power consumption would be reduced considerably with streamline cars, it being known that horsepower increases as the cube of the speed.

But that this type of testing is not new is evidenced by the earlier attempts to solve problems of wind resistance. In Fig. 6 is shown a test on biplane wings made in 1918 by a prominent aircraft manufacturer. To find the direction of air flow in this case the surface of a black enamel plate was shellaced and powdered with graded sand from a height of about four feet. Shaking off the surplus left the plate ready for use. Fine talcum powder, introduced into the air in the wind tunnel, formed into a neat streamline deposit behind each grain of sand, indicating clearly the direction of travel.

Bearing Metal Bonded to Shell

BEARINGS being common to the design of every class of machine, the development of a method of lining steel tubing with various metals and alloys primarily for bearing purposes is particularly pertinent. The new product recently was introduced by Detroit Seamless Steel Tubes Co., Detroit.

In the past it usually has been the practice to tin the shell of a bearing and to sweat the actual bearing material in place, or to form a mold around the inner face of the shell and pour bearing metal in. The new process however, combines the inner lining with the outer shell, bonding the two materials together so inseparably that there is no manual means of destroying the union.

One of the important advantages accredited to the process is the homogeneity of the texture of the lining metal, this being cast into the tubing by a centrifugal process. Bearing metal is, of course, much superior when cast in this manner.

Apart from bearings, there are many other practical applications for this type of lined tubing. With only a thin shell of inner lining, the product could be used economically, for instance, as tubing for carrying corrosive liquids; for water tube boilers; or for water pipes to be used instead of tubes of copper or other material where strength is essential.

Steel Castings as Machine Parts

By R. A. Bull

Fig. 2—View of structure in carbon steel specimen two inches square, in condition as cast

THOSE of us who belong to the older generation which still regards itself favorably from the standpoint of usefulness, and which in the formative period of life, was influenced by dissertations on men and manners by Oliver Wendell Holmes rather than by Henry L. Mencken, have not forgotten the recipe once considered to be cleverly truthful, prescribing that, to make a gentleman, one must first take a grandfather.

Conditions change radically with the passing years. And our rapidly developing civilization, disregarding a nicely turned phrase, has produced a great many gentlefolk of ability and distinction from persons who had very lowly births and unpromising early environments. But, however the developing process may have been speeded up for enabling men and women to acquire impressive characteristics of refinement, an analogy may yet be drawn between the once-declared hereditary requirement of gentility and the production of a satisfactory steel casting. The all-important grandfather of that particular metal part is its designer. The old man was, is, and ever will be, indispensable. And the birthplace of the child is the drawing board.

The longer one remains in the business of manufacturing steel castings for the jobbing or miscellaneous trade, the more he realizes the great need for emphasizing the factor of design in conferring serviceability on the product of the industry. This factor is highly important in the production of any part, made from any kind of metal. But because of the high degree of shrinkage or contraction that attends solidification of steel after it is poured, the element of design is more influential in producing soundness in a steel casting than in the case of any other ferrous casting. Steel shrinkage amounts roughly to a quarter of an inch per foot. The significance of this may be appreciated when we realize that not a few steel castings are upwards of 40 feet long; and that the length of the mold for such a casting, also the space occupied by steel immediately after the mold cavity is filled, must be approximately 10 inches greater than the required length of the cast unit of equipment. The shrinkage of gray iron is approximately half that of steel, consequently contraction difficulties are lessened when casting the weaker metal.

Fig. 1 — Typical view of structure in cast carbon steel specimen one inch square, in raw or unannealed condition. This and later specimens illustrated were etched with five per cent picric acid, magnification × 100

Surface Cools Before Center Portion

Consider what happens when a sand mold is filled with steel. There is an immediate chilling of the surface of the metal, so that a skin forms quickly. The central regions of members that are thickest, cooling most slowly, solidify last. In the case of massive sections these interior portions remain red hot for an appreciable period, sometimes amounting to days.

It has been known for a long time that crystal formation in metal is the result alone of cooling that follows heating at a high temperature; and that the longer the period of cooling required before a piece of steel reaches a temperature indicated by what is called black heat, as distinguished from visibly demonstrated heat, the greater the tendency to form.

SOME conditions the engineer should keep in mind when designing steel castings are discussed in the accompanying article, the first of a two-section series. Major Bull is director, Electrical Steel Founders' Research Group, Chicago, and is a well known authority in the metallurgical and steel casting fields.

Fig. 3—View of structure in cast carbon specimen four inches square, raw or unannealed

Thus it comes about that a casting having relatively thick and comparatively thin members that are connected must possess, in the condition as removed from the mold, a granular structure in its heavy sections that differs materially from that in its light members, unless some expedients are employed by the foundryman to counteract the influence of mass. We later shall refer to such devices.

Dendritic Structure May Form

Another condition, distinguished from large grain size to some extent, although closely related to it, may exist in a mass of steel that is so heavy as to necessitate very slow cooling while it freezes. What is called a dendritic structure is developed frequently. The term is given to those formations that resemble angular branches of pine trees, and the structure is extremely difficult to break up completely by any form of heat treatment subsequently aplied. Some dendrites seem to be incapable of being eliminated. When the crystals are placed in a fashion that justifies describing the structure as dendritic, there are more or less continuous lines of potential weakness present in the metal.

There is still another result of mass in steel which natural laws bring about. Greatly retarded cooling sometimes gives rise to the harmful segregation of certain elements in the chemical composition; so that, while in all probability they were well distributed in the liquid metal, if properly made, there is a tendency for some of these elements as separate groups to collect around nuclei, permanently disturbing the original state of satisfactory distribution. Since the good behavior of steel under stress depends to considerable extent on a material that is practically the same constitutionally in each small unit of area, the harmful effect of segregation may be partially appreciated. It is capable of demonstration by physical test.

It seems desirable to include here some technical matter to illustrate structural conditions that have been mentioned and should, when possible, be avoided. Some persons whose business it is to use, rather than to make, metals may perhaps understand the conditions related to inequality of section by noting the examples illustrated. These require no long explanations to permit them to tell an interesting story.

From carbon steel (0.25 per cent) of a grade often used for structural purposes, specimens of several sizes, suitably fed by risers or headers, were cast to ascertain the influence of mass on structure.

Fig. 1 is the reproduction of a photomicrograph presenting a typical view of a bar six inches long and one inch square, showing the raw or "as cast" condition of the metal, solidified in a sand mold of small cross section. The relatively rapid cooling after pouring is indicated by the structure.

There is shown in Fig. 2 a view of another bar six inches long and two inches square, in its unannealed state. The structure is beginning to assume a different aspect, as solidification becomes slower.

Fig. 3 illustrates the condition in a block

Fig. 4—Photomicrograph of structure in condition as cast, in carbon steel block twelve x ten x ten inches in size

from this heat, eight inches long and four inches square, also in the condition as cast. More retarded cooling leaves its evidence.

Fig. 4 shows the structure, unchanged by heat treatment, in a block 12 inches by 10 inches by 10 inches in size. The effect of the very slow freezing of the metal on structure is quite evident.

In Fig. 5 is reproduced a photomicrograph made after efforts to break up the structure by a method that has less practical application to massive steel castings than to wrought material. From the block that was 12 inches by 10 inches by 10 inches in size a slice one-half inch wide and one and one-half inches deep was cut from an edge of the block to its center. This block previously had been heated at 1650 degrees Fahr. (899 degrees Cent.) for one hour. The thin slice was reheated at 1650 degrees Fahr. for three hours. The photomicrograph (Fig. 5) subsequently was taken from a portion of the slice that had been in the center of the block having a cross section of ten inches. As will be seen, the metal successfully resisted the effort applied through this treatment, to develop a structure similar to that in steel of the same grade but solidified in a piece of moderate cross section.

Fig. 6 shows a view of a bar two inches square,

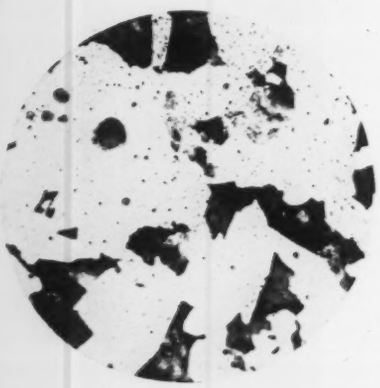


Fig. 5—View of structure in specimen twelve x ten x ten inches after treatment to reduce grain size in thin sample taken from interior of block

heated at 1650 degrees Fahr. for three hours, but without any preliminary heating such as the massive block received.

W. J. Merten* has advocated an elaborate heat treatment which requires three heating and three cooling procedures, and a complete cycle necessitating about 45 hours for six-inch sections, and a longer cycle for thicker sections, for developing such satisfactory physical properties in the interior of a very thick steel casting as are found ordinarily in a medium-size member of a casting of comparable composition. The temperature advocated reaches the maximum of 2012 degrees Fahr. (1100 degrees Cent.). Treatment of similar nature has been recommended by Mr. Merten to develop satisfactory physical properties in massive sections of steel forgings. Incidentally the tests made by this investigator and by others show tensile properties in the central portions of heavy sections of steel castings to be fully as satisfactory as those in the hearts of comparable sections of steel forgings.

*"High Temperature Treatments of Castings and Forgings as Evidenced by Core Drill Tests from Heavy Sections," Transactions of American Society for Steel Treating, Vol. XIII, No. 1 (January, 1928).

High Heat Affects Thin Sections

The cited recommendations of an extraordinary heat treatment were made by a metallurgist of high standing, whose test results are not doubted by the writer. But, collectively considered, the treatments are such as to make them appear of questionable desirability, when applied to members of radically differing thicknesses in the same piece of steel, either wrought or cast, provided some of the members are small enough in section to be classed as light. Thin members suffer from sagging or distortion, as

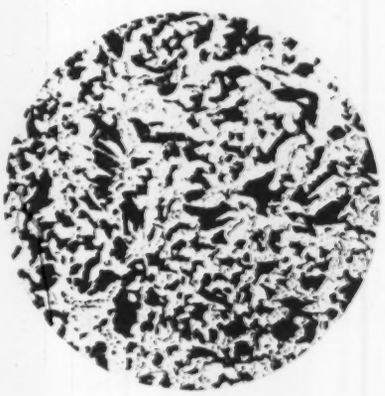


Fig. 6—View of structure in block two inches square, heat treated according to the procedure applied to the block whose structure is illustrated in Fig. 5

the result of intense heat applied for a very long time. Oxidation forms a heavy scale, materially reducing the cross-sectional area of a thin member. A heat treatment method to relieve the conditions created by unequal sections does not appear to be conveniently applicable.

A factor that is unrelated to the conditions of varying grain size, dendritic structure, and segregation, lies in the difficulty sometimes experienced by the foundryman in supplying reservoirs of metal by means of sink-heads or risers, for feeding a casting having thick members that underlie thin ones (considered from the standpoint of the most satisfactory pouring position for the mold). There are castings so designed as to leave the foundryman no opportunity to display ingenuity in placing in what we may term a "feedable" position in the mold, that part of it which is to form a massive section of the casting.

An example of this is illustrated in Fig. 7, showing a sectionalized steel casting, purposely machined (destructively) to ascertain the condition of the interior of a part whose design justifiably aroused doubt regarding soundness. A casual glance at the illustration indicates the

insuperable handicap presented in efforts to pour the casting in any manner that satisfactorily would provide metal for the heavier portions that cooled slowly and required, for solidity, considerably more metal from risers than was needed for the thinner members of the same casting.

Naturally the casting illustrated was unsound, due not to the carelessness of the casting maker, but to the mistake of the casting designer, or to imposed conditions of application that necessitated metallurgically incorrect proportions of the piece.

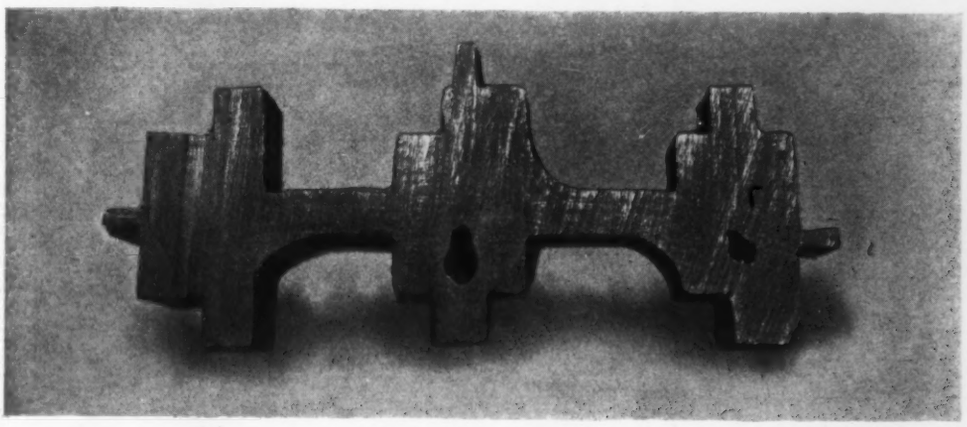


Fig. 7—Section of steel casting having thick members inaccessible to risers or sink-heads needed to feed them for the prevention of shrinkage cavities

The casting mentioned constituted an extraordinary case, the equal of which is rarely duplicated in degree of metallurgical deformity. But it should be remembered that this condition, varying greatly in extent, exists in many cases and often could be eliminated or ameliorated with material benefit to serviceability, as the result of appreciation in the design department of the physical laws that govern the behavior of metal when it is liquid and when it is acquiring a state of solidity.

Design Suggestions Are Offered

The writer has tried to proceed logically with his explanations and illustrations of some metallurgical phenomena, to the first of two premises that may be laid down for the guidance of the man who develops on the drawing board, the proportions of a steel casting. One primary principle may tersely be stated thus: A steel casting that is perfectly designed metallurgically has the same thickness in every member. Obviously, when this principle is put into practice it must be amended, to mean something like this: A steel casting should have as much similarity as conditions of use permit, in respect to member thickness. For the application of this principle there needs to be widely distributed, information that only can result in improved serviceability of the product of the steel foundry, when engineers whose business it is to design cast steel parts, keep in mind this highly important matter to greater extent than they have observed it in the past. Incidentally, it is believed mistakes of the kind suggested have been more the result of unconscious reticence on the part of foundrymen than of conscious indifference on the part of designers.

One naturally might be prompted to ask what the foundryman can do to counteract in some degree the effects of thick section in a casting having members of widely varying thicknesses, by providing a cooling velocity for the thick members, not radically different from that observed in the thin members, during the solidification process. Some persons might take it for granted that an experienced foundryman knows how to counteract all inequalities of this kind, and that the answer is found in molding technique. It is true that the skilled steel founder can overcome some such conditions to considerable extent. Recourse is had more or less frequently to the use of chills, either internally placed, or set in such a manner as to influence only the surface of the metal, or sometimes applied by both methods, according to the seriousness of sectional difficulties. Probably such expedients are useful in most cases. The foundryman would greatly prefer not to employ them. They are expensive, partially effective devices that could be dispensed with advantageously in numerous instances where they now are needed, if designer and founder would collaborate more frequently. Sometimes chills are decidedly harmful. They should be employed only with experienced discretion.

In the cases of some castings of special nature in which radically differing thicknesses of members exist, there has been applied the expedient of water-jacketing a part of the mold, so as to permit heat conducted by radiation through the sand lying between the water-jacket and the heavy mass of liquid steel, to be carried away from the mold by circulating water. When this method of overcoming a design defect is utilized, great care and considerable expense for mold construction are necessary. It should be kept in mind that, for all such items of extra cost involved, the consumer eventually has to pay.

Constant Acceleration Cam Design

By H. F. Shepherd

WHAT designer has not devised a cam operated mechanism on kinematic principles only to stumble over the inseparable kinetics? On the drafting board and perhaps in the form of a model turned by hand it may be a beautiful example of mechanical ingenuity but in metal and operating at the desired speed the cams and rollers show signs of distress.

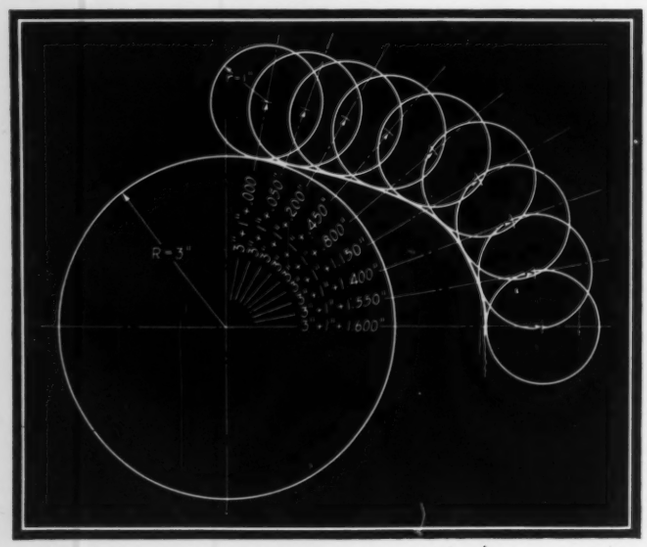
Time and force are required to accelerate and decelerate a mass. Much useless effort is put forth if the force needed to do this work is irregular due to greatly varying rates of change of velocity when mere translation of the mechanism from one position to another in a given time or angular movement is all that is required.

The same work could be done in the same time by the mean value of the force curve with perhaps far less stress on the mechanism. Slight modifications in cams have resulted in reducing acceleration forces to one-fourth of their original peak value, reducing noise and wear or allowing machines to function at greater speeds.

The hyperbolic or constant acceleration cam profile when it can be used is ideal. It often is called the gravity curve cam because it follows the same laws as do falling bodies.

These are expressed by the following formulas: $S = \frac{1}{2}\ a\ t^2$, and $V = a\ t$; in which $S =$ movement in time t, and $V =$ velocity.

Units of any sort may be used as long as they are employed consistently.



Layout of constant acceleration cam profile

Thus t may be given in seconds, but if a profile layout only is needed t may signify a given number of degrees or we may even give it a value indicating that it is equal to one or more equal spaces into which the cam base circle is divided.

Thus if a cam function requires 80 degrees it may be divided into eight equal spaces of 8 degrees each numbered consecutively as one, two, three, four, five, six, seven and eight. As the machine drive operates usually at a constant speed of rotation these spaces represent equal intervals of time.

Let it be desired now to lay out a constant acceleration cam with a lift of 1.6 and rise to full lift in 80 degrees. For this case let acceleration be uniform to half lift and use deceleration at the same rate from mid-lift to finish.

Divide the cam base circle into eight equal spaces.

Mid-lift of .80″ is reached at the end of the fourth space. The square of four is 16 so in the relation: $S = \frac{1}{2}\ a\ t^2$, the constant:

$$\frac{1}{2}\ a = \frac{S}{t^2} = \frac{.800}{16} = .05$$

Tabulating,

t	t^2	$S = .05\ t^2$
0	0	.000
1	1	.050
2	4	.200
3	9	.450
4	16	0.800
5	....	1.150
6	....	1.400
7	....	1.550
8	....	1.600

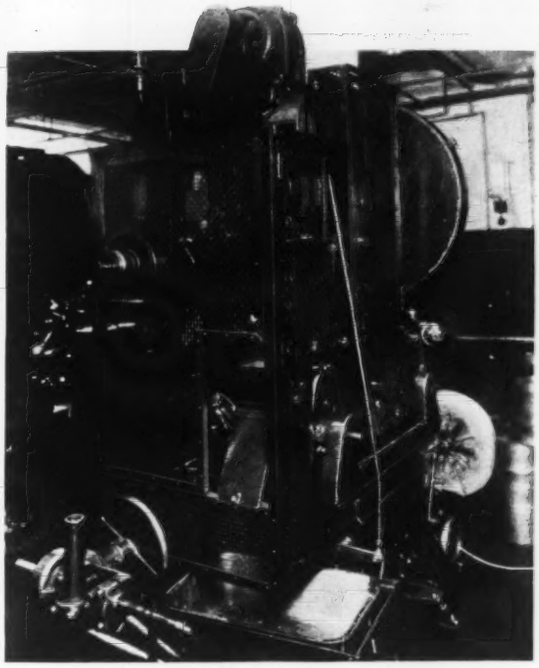
The second half or retardation period of the profile is merely the reverse of the first.

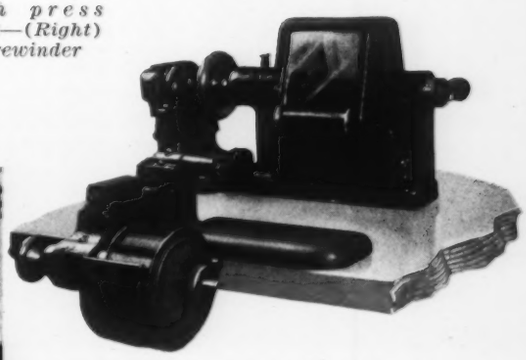
If it is desired to know the actual kinetic force in pounds, substitute time values in seconds for t and express s in feet solving for a in feet per second^2. With $g = a$, due to gravity, as 32.16 feet per second^2, $a/g\ W =$ force at cam roller, in which W equals the weight of reciprocating parts reduced to the cam roller center.

Also solve for V in feet per second if desired.

The layout is best given to the shop as shown in the drawing. In this form the master cam may be worked out on a dividing head with a milling cutter of the same size as the cam roller. More points should be given in the table than in the example for this purpose. This is done easily by dividing the cam function into a greater number of equal spaces than have been used.

Fig. 1—(Below)—Punch press with single guard. Fig. 2—(Right) —Efficiently guarded rewinder





Safeguarding the Operator

By J. H. Lonie
Engineer, Western Electric Co.

WHEN planning a new machine, it always is well to co-ordinate safety features with other features of its design. This usually can be accomplished satisfactorily and often results in a more efficient machine than otherwise could have been designed.

In addition to safeguarding the machine to prevent injury to the operator, attention should be given to minimizing any inconvenience to the operator that the application of such safeguarding might present.

Many machines now in use throughout the country are inadequately equipped with safety features for the protection of operators and passersby against the hazards of exposed drive belts, chains, cams, pulleys and other moving parts, as well as chips, oil, etc.

In adding safeguarding features to a machine not originally designed to incorporate them, it often is difficult and sometimes impossible to secure that compact and symmetrical appearance so desirable in any mechanism. From the standpoint of economy it is necessary, when contemplating the addition of safety devices to a machine, to compare the cost of such features with the cost of the machine itself. It frequently is found, as in the case of a machine which has been in service for a long period of time, that the cost of the necessary safety features is excessive. Consideration then is given to replacement by a new machine which includes the desired safeguards.

Examples of machines incorporating safety devices which have been added since installation, are given in the following. It is believed that these will assist in focusing the attention of designers on the desirability of considering such features in initial designs.

An automatic punch press (Fig. 1) requiring several guards to cover rotating or reciprocating parts which presented operating hazards, was covered at the rear and sides by a single guard unit composed of several sections hinged to permit access to machine parts. One not experienced in the application of safety features to machinery might wonder why an individual guard for each point of hazard was not used in this case, because of the better appearance such guarding would present to the eye.

Availability an Important Feature

Individual guards were not used because—first, the close proximity of the guards would not permit their being designed with sufficient accessibility to allow economical inspection or repair of the machine parts, and second, the cost of such a large number of guards designed

and produced singly, would be prohibitive.

A simple but effective guard for a wire rewinding machine is shown in the closed position in Fig. 2. This guard, hinged at the rear, consists of a casting, the open front of which contains an idler roller above which a pane of shatterproof glass is inserted. The purpose of the guard is to prevent small pieces of wire from the rapidly revolving rewinding spool being thrown off with the possibility of injury to the operator or other persons in the vicinity of the machine.

It is found, not infrequently, that guards cannot be used to eliminate the hazards in a machine because of the nature of the work done on the machine. In such a case, it is necessary to devise a safety mechanism to meet the specific requirements involved. An example of a safety device of this nature installed on a rubber mixing machine is to be seen in Fig. 3. The mechanism consists of two cross bars at either end of which is a supporting bracket suspended pendulum-like from the upper part of a housing located on top of each side frame of the machine. One of the housings contains a rotary switch which projects outside the housing and if moved only a fraction of an inch by a pin extending through the center lug of one of the cross bar supporting brackets, actuates the mechanism, causing the driving motor to act as a brake and stop the machine. The empty machine is stopped in a 7½-inch travel measured on the periphery of the faster mixing roll which is 18 inches in diameter. The cross bars are so located that either the body or head of the operator would move them if both of his hands were caught between the mixing rolls. The machine may be stopped from either side by a slight pushing or pulling movement of the cross bar.

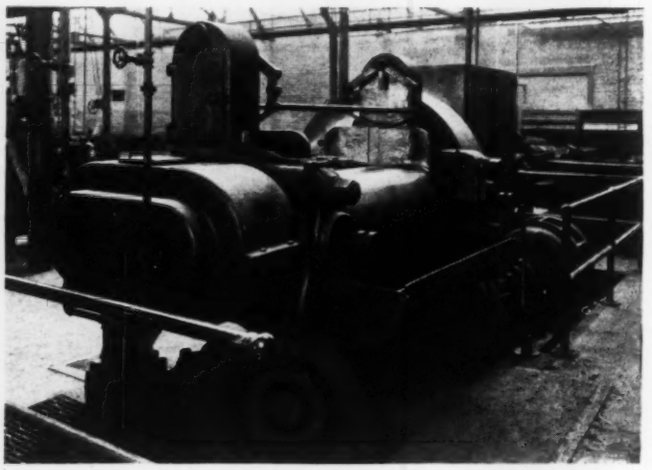


Fig. 3 — Device installed on rubber mixing machine where guards cannot be used to eliminate hazards enables quick stopping and reversing of rolls by the slight pushing or pulling of a cross bar by a free hand or operator's head. It can be operated from either side of the machine

Two-Hand Control Provides Safety

Another example of the application of a safety device to a machine not adapted to guards is that of the two-hand control as applied to a paper shear, as shown in Fig. 8. In this case two levers, one on either side of the machine, must be operated simultaneously to start the shear. If either hand is removed from these levers, the machine will stop instantly.

A machine, every moving part of which is guarded, is shown in Fig. 11. This machine is used for removing the sheath from defective lead covered telephone cable. One safety feature used here is an interlocking cam on the electric control switch lever which prevents the opening of the door over the rolls until the lever is in the "off" position, at which time all power is disconnected. The cam provides a two-way interlock so that while the door is open, the switch lever cannot be moved from the "off" position and the machine cannot be started until the door is closed.

Thorough guarding of a belt sander is shown in Fig. 10. The motor, at the lower left corner of the machine, is covered by a sheet metal housing while the various chains, the sanding belt and other moving parts are covered by sheet metal guards. All of these guards are either hinged or have covers which may be removed readily to permit inspection or repair of the machine. The hinged chain guard covers contain a lubricator which releases a drop of oil at regular intervals upon the chain. At the upper left of the machine the guard over the sanding belt opens into an exhaust pipe which carries away the dust created by the machine.

Safety features as adapted to a single purpose wood turning lathe, are shown in Fig. 5. A sheet metal guard hinged at one end on a bracket fixed to the rear side of the headstock, is lowered until it strikes a stop. In this position it covers the lathe chuck and prevents chips or blocks from the work being thrown beyond the confines of the machine. A floating section consisting of a semicircular piece of sheet metal, hinged at the rear on either side of the guard, and yoked by a flat piece resting on the guard, permits the guard to be used for any variety or size of work that may be done on the machine. To make the guard additionally flexible, four pieces, adjustable vertically by loosening a wing nut in each, are fixed to each side of the floating section to accommodate the various tool setups required. The guard has a handle at the front by means of which it may be raised or lowered.

Design Safety into Machines!

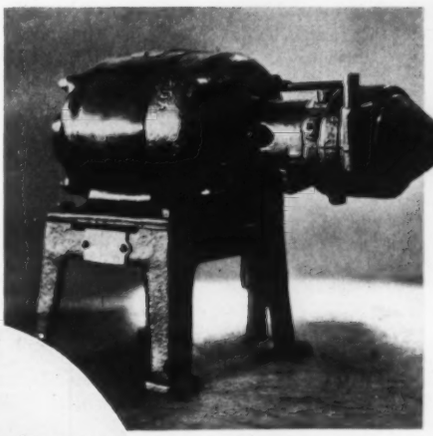
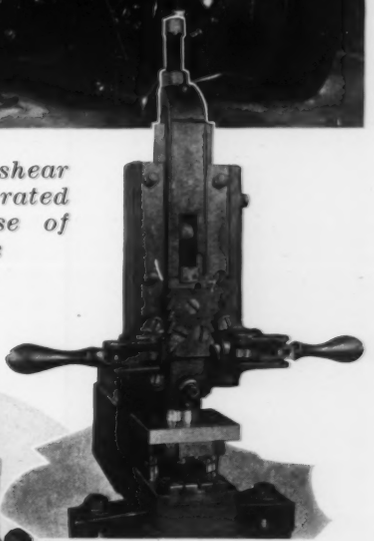


Fig. 4—(Right)—Burring motor is designed to provide maximum safety of operation

Fig. 8—Paper shear cannot be operated without the use of both hands



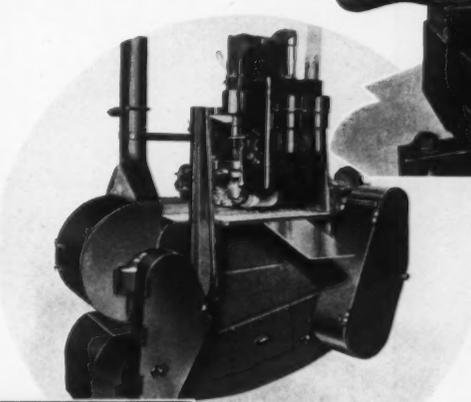
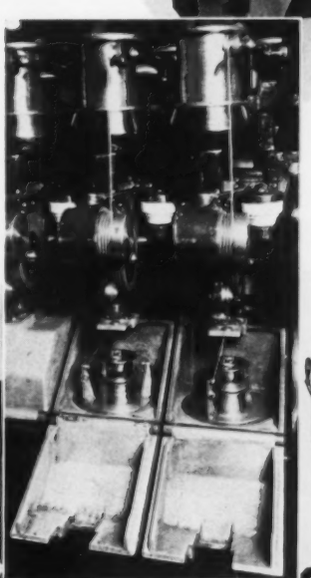


Fig. 9—Another machine which cannot be started without using both hands

Fig. 5—(Above)—Sheet metal guard in design of wood turning lathe prevents chips being thrown. Fig. 6—(Below)—Every hazardous feature is fully guarded in tinsel serving machine. Fig. 7—(Right)—Two of the guards incorporated in the machine in Fig. 6



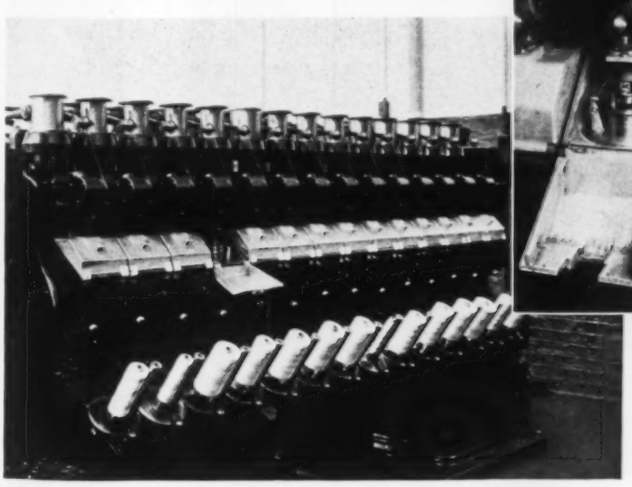


Fig. 10—(Above)—Belt sander has moving parts covered with individual sheet metal cases

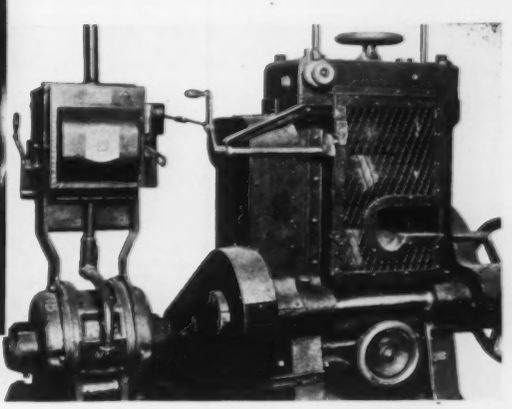


Fig. 11—Every moving part is covered in the design of this machine for removing sheath from telephone cable

A counterweight attached to a lever projecting from the rear of the guard balances it and reduces the fatigue incidental to frequent raising and lowering. The shaft upon which the guard is hinged is of sufficient length to permit the guard to be moved to any position ordinarily required. An arm, attached to one end of the shaft upon which the guard is hinged, follows the movement of the guard and is arranged to actuate a switch at the rear of the machine. This switch either opens or closes the electric circuit leading to the regular machine switch in front of the lathe. The machine cannot be started until the guard has been lowered, as the circuit leading to the machine switch is open when the guard is raised and closed only when the guard is lowered.

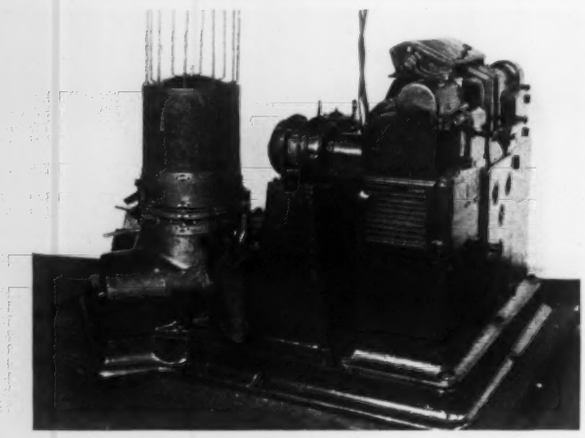


Fig. 12—Intercoupled guards designed for fuse cut-off, slotting and reaming machine stop all motion when one is opened

Attention now will be given to a few examples of special machinery in the design of which safety features have been given full consideration.

A design showing simplicity and neatness is seen in the burring motor, Fig. 4. This machine, consisting of a motor to which a chuck holding a standard drill has been attached, is used for burring holes. A casting which serves the purpose of motor end bell and chuck guard is split at the outer end to permit the clamping of a drill guard. The drill guard fits inside the outer end of the chuck guard and may be adjusted to suit any length of drill.

Aluminum Guards Protect Operator

Fig. 6 shows a tinsel serving machine in which every hazardous feature is fully guarded. The aluminum guards, one of which is open as shown in the illustration, cover mechanisms which revolve at high speed. That unit of the machine to which this guard is attached cannot be set in motion until the guard has been closed, nor can the guard be opened without first stopping the machine. Fig. 7 shows two of these guards opened up so they may be seen more clearly.

Another example of thorough machine guarding is that of the fuse cut-off, slotting and reaming machine shown in Fig. 12. All moving parts are covered by guards which are inter-coupled with one another so that if one of them is opened, all motion in the machine will immediately cease and the machine cannot be started again until all of the guards have been returned to their normal positions.

Complete Guarding Is Provided

A machine used for neutralizing and polishing fuses is shown in Fig. 13. This presents a splendid example of safeguarding. The motor driving the machine is located in the body of the machine itself, completely concealed but easily accessible through the hinged doors seen in the illustration. Wire scratch brushes, buffing wheels and other parts are completely covered by guards.

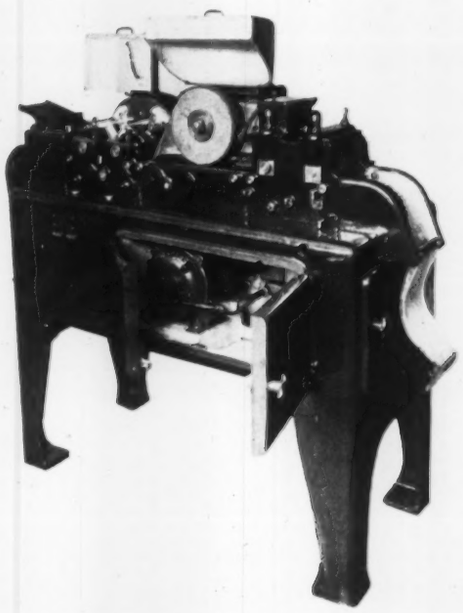


Fig. 13.—Machine for neutralizing and polishing fuses is splendidly designed to provide maximum safety

While it is possible efficiently to guard machinery already built and installed, the best place to evolve the safety features required in connection with a given mechanism is on the drawing board, before the machine is built. Both money and time are saved, and the equipment usually present a better appearance than if additions are made later. If the machines are built for sale, the suggested procedure should be followed even more closely. Incorporation of safety devices in the original design will place the builders in an advantageous position in competition with other manufacturers on whose machines such features have not been given due consideration.

Designing for Rapid Production of Spiral Welded Pipe

By Leon Cammen
Consulting Engineer, New York

SPIRALLY welded pipe is by no means a new product a quantity having been made more than seventy years ago. There are several types of welded pipe known. The simplest, which is straight-butt welded, was the first to be made, but did not become important until the machinery for making it had been perfected, and particularly until electric welding made large production possible. Lap-welded spirally coiled pipe came next. This was tried but did not prove commercially important. The third type, made by the Naylor Spiral Pipe Co., Chicago, is decidedly interesting. In this type the edges are lock-seamed in coiling, and the seam subsequently welded to make the joint air and water tight. The welding is done in a separate machine, and as comparatively slow arc welding is used, it takes a number of welders to keep up with one coiling machine. The lock-seam forms a ridge the entire length of the pipe.

Problems of a mechanical nature in making spirally welded pipe, which arise in connection with the design of a mahine for this purpose. may be enumerated as follows: 1. Preparing the skelp; 2. Coiling it into the desired shape; 3. Joining the seam; 4. Welding the seam; 5. Cutting off the pipe. It is proposed to discuss the first three features in the following. And to refer to the problems encountered in the welding and cutting of the pipe in a subsequent contribution.

Preparing the Skelps

In longitudinally welded pipe it is the usual practice to use pieces of skelp just long enough to make a pipe of a given length, allowing for waste at the ends. This waste is a serious matter as, e.g., in the A. O. Smith company's practice, it takes a piece of skelp 45 feet long to make a pipe 40 feet long. Where hydraulic presses are used, this practice becomes imperative. Where the pipe is bent in rolls, as in the Yoder machine, It theoretically is possible to use coils of strip of indefinite length, but thus far no one seems to have followed this method.

In making spirally welded pipe the use of strip in coils of great length obviously is the proper practice. There is a piece of skelp that usually cannot be made use of; this is the end that remains in the guide table (referred to later) between the feed rolls and the bending rolls. In coiling short lengths this piece not only would be wasted but it would have to be taken out at some cost in time and money. The best procedure to follow therefore is to weld the edge of the

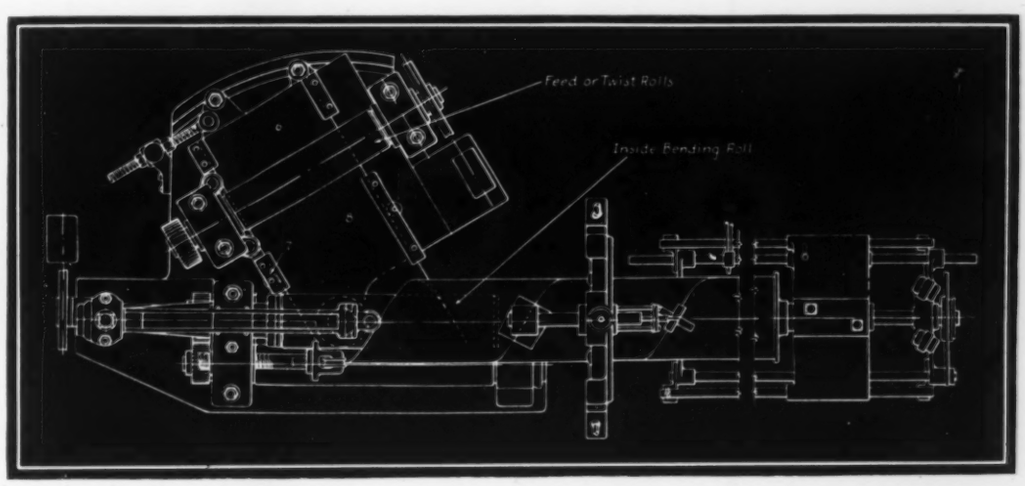


Fig. 1—Plan view of spiral pipe machine showing angular setting of feed and bending rolls. At 7 a milling fixture is used for trimming the strip to width

next piece, after careful trimming to the back end of the piece being rolled, thus making a practically endless coil of skelp. This method of welding one end of the strip to the other, as a commercial proposition, is a comparatively recent development, but proves to be quite successful.

The next question concerns the matter of width and edge of the strip. Skelp used in pipe making must be of strictly correct width, as

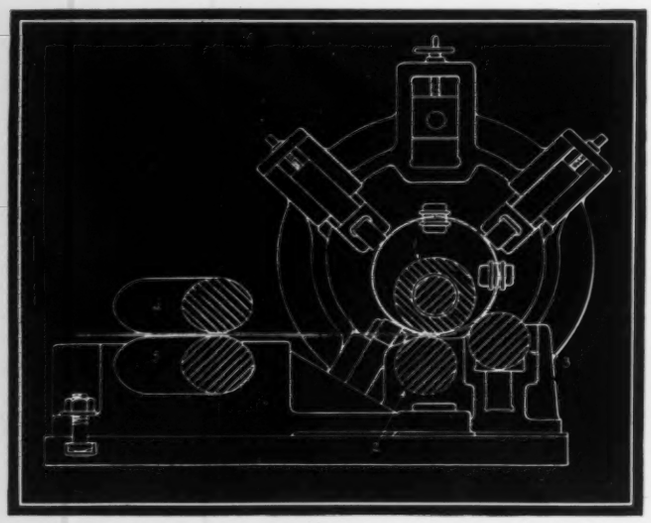


Fig. 2—Section of machine through the rolls. Note guards for holding strip after bending

otherwise the completed pipe will look like a snake. Where the shape of the edge does not matter, the simplest way to secure correct width is to trim the coil to skelp in a planer, first on one and then on the other side. Mill tolerances on width are fairly strict, e.g. the width should not vary more than ¼-inch in 24 inches. For pipe welding only positive tolerances should be allowed. In some cases welding conditions require, however that the edge be properly shaped or bevelled.

Special Fixture Used With Mill

To perform this, a special fixture has been incorporated into the common pipe mill under discussion (see 7 Fig. 1). The character of this fixture depends on the type welding adopted. Where arc welding is used, the speed of the skelp travelling through the mill is so slow (from 1 to 2 feet) that an ordinary single milling head will meet the requirements. Where resistance welding is used, however, the speed of the skelp may be as high as 20 feet per minute, and for this condition a special fixture consisting of a consecutive series of "shaving dies" has been developed. Their use is made possible by the fact that the amount of metal to be removed is at best small, and hence the heating of the cutters is not great.

The idea of spirally coiling skelp is not only not new, but one that is being practiced extensively today in other fields than welded pipe, as witnessed by the familiar spirally coiled mailing tube. There is however a considerable difference between a cardboard mailing tube and a welded steel pipe. Referring to the latter, there are two ways of coiling skelp. In both methods two sets of rolls are used, namely feed rolls to deliver the skelp and bending rolls to coil it. The difference is in the matter of distributing the work between these two sets of rolls.

Bending Rolls Usually Carry Load

The way hitherto has been to load most of the work on the bending rolls, using them as similar rolls are used, for instance in boiler making. In the section, Fig 2, 1 is the inside bending roll, and 2 and 3 the outside rolls. The feed rolls are shown at 4 and 5. Obviously, the closer the inside roll is set to the outside bending rolls, the smaller will be the diameter of the pipe produced, and the more power can be applied through these rolls to the skelp, until ultimately the pipe will be made of the same inner diameter as the outside diameter of the inner roll, and a completely rigid structure will be obtained. By applying enough power to the bending rolls, the whole work of coiling can be taken care of. A slight modification of this process is evident in the Naylor system. In this, so much power is applied for the purpose of lock-seaming the edge of the skelp that the matter of coiling the skelp becomes secondary inasfar as power consumption is concerned.

In the Cammen mill an entirely different process has been resorted to, and the skelp is not pulled, but pushed through the bending rolls. All the driving power is applied to the feed or twist rolls 4 and 5, the bending rolls in the small mills not being driven at all, and in the larger mills being driven just enough to turn over. The result is that the bending rolls act more as a mere guide than as active elements, which requires of course that they be set much further apart. This in turn makes the diameter of the pipe much greater than the inside roll, and incidentally makes the proper hardness of the skelp more important as a factor controlling the diameter of the coiled skelp.

The only important advantage of pushing the skelp through the bending rolls rather than pulling it is that the former method affords better control of the speed of motion of the skelp through the rolls. This may become an important factor in those forms of welding where the current in the welding device, be it arc or resistance wheels, is proportioned to the speed of travel of the skelp. The pressure in rolls 4 and 5 is controlled by the screwdowns with the operation of which we all are familiar, while the resistance to the passage of the skelp through

the bending rolls is fairly constant. This has been found to be otherwise where the skelp was pulled through the rolls.

Forces Acting on the Skelp

An important matter to which but little attention has been given in the past is connected with the forces that act on the skelp. Obviously, the main work is done in the bending rolls. In a way these rolls act as a coiler in a strip mill. If coiling were the only thing the rolls had to do, the power consumption of the mill would be extremely low. In addition to this, however, the skelp has to move forward, and in doing so the skelp must overcome a large amount of friction which increases with the closeness of setting of the inside bending roll 1 with respect to the outside rolls 2 and 3.

This method of operation has a rather peculiar result. As the metal is pushed through the twist rolls 4 and 5, it encounters an enormous resistance to flow due to friction in the bending rolls, in addition to the resistance due to bending. As it is easier for the metal to bend only, instead of pushing its way through a narrow gap in addition to bending, the metal simply bulges up between the twist rolls and the bending rolls and refuses to continue its progress through the latter.

The answer to this misbehavior of the skelp lies in the provision of the guides shown as to location at 6 and 8 in Fig. 1. These guides each consist of two plates with a narrow space between, just wide enough for the metal to go through. It has been found to be important that the width of the slots for passing the metal through should not be excessive. The reason for this is somewhat complicated by the factors concerned.

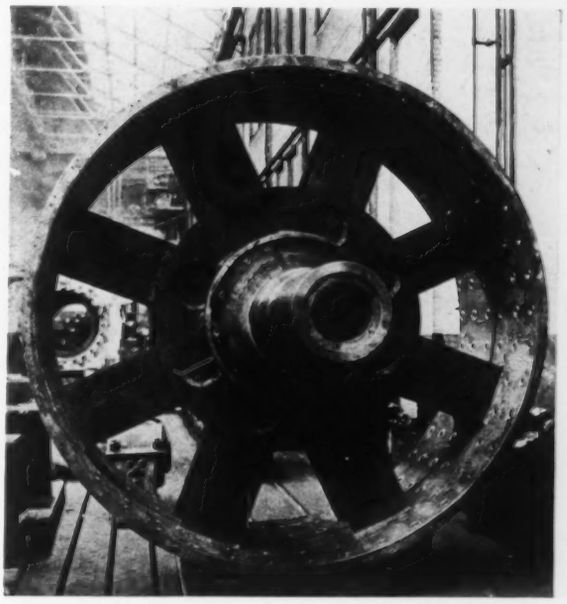
Angle of Twist Rolls Affects Spacing

Obviously, the bending rolls alone will coil the metal but will not push it forward as the axes of the bending rolls are parallel to each other and therefore the rolls have no component of force acting endwise. This endwise push is produced by setting the twist rolls 4 and 5 at an angle to the bending rolls. It is evident that the angle of the axes of the twist rolls to those of the bending rolls affects the spacing of the seam, i. e., the distance between the edges of the skelp in the seam, and this spacing has to be controlled closely as the quality of the weld is affected thereby. Now, if the slot in the plate guides 6 and 8 is so wide that the skelp can shift sidewise, this is apt to change the true angle between the direction of the skelp as it comes out of the twist rolls, and this in turn changes, often disastrously, the spacing in the seam.

If the combined action of the twist and bending rolls imposes on the skelp a tendency to shift to the right in the latter rolls, there will be a counter tendency for the skelp ahead of the twist rolls to shift to the left. To obviate this, guides 6 have been provided. Where, however, skelp is used that has not been trimmed previously, these guides become somewhat tricky in that they have to handle skelp of variable width and yet maintain it in its proper position at all times. One way to meet this difficulty is to have the skelp trimmed, which among other things can be done by placing the milling fixture ahead of the plate guide 6. Another way is to provide a powerful spring control of the edges of the guides in 6. The former is to be used in the large Cammen mill now under construction; trimmed skelp only is used in the mills installed at present.

Welding Design Gains in Efficiency

IN DESIGN the use of welding has progressed to the point where manufacturing methods have taken a place parallel to riveting and castings. The illustration shows an application where welding is used to obtain maximum efficiency of



Exceptional vibrational stresses are distributed uniformly through the welds on this ship rotor

connections. This particular rotor, 148 inches in diameter, was designed to withstand exceptional vibrational stresses, distributing them uniformly throughout the weld with a minimum of stress concentration in both weld and welded members.

This rotor is for a ship propulsion motor, which has a rating of 13,250 horsepower, 133 revolutions per minute.

Developing Springs Graphically

By M. G. Van Voorhis

BEFORE the development of the more accurate spring formulas, the need for a quick method of designing helical round wire springs was great, but with the use of the stress correction factor recently introduced and described in past issues of MACHINE DESIGN by A. M. Wahl, this need is even greater than before.

The accompanying chart has been constructed in an attempt to meet this need and at the same time tie up with the old procedure of design. Without the correction scale, the results are as obtained by the old standard method, and in order to obtain the corrected figures, the results obtained on the C and W scales are divided by the correction factor. This extra computation saves further complication of the chart which might become too confusing.

Formulas used in the construction of the chart are as follows:

$$\frac{D^2}{d} = \frac{C}{n} \times \frac{G}{\pi S} \quad \text{.....(1)}$$

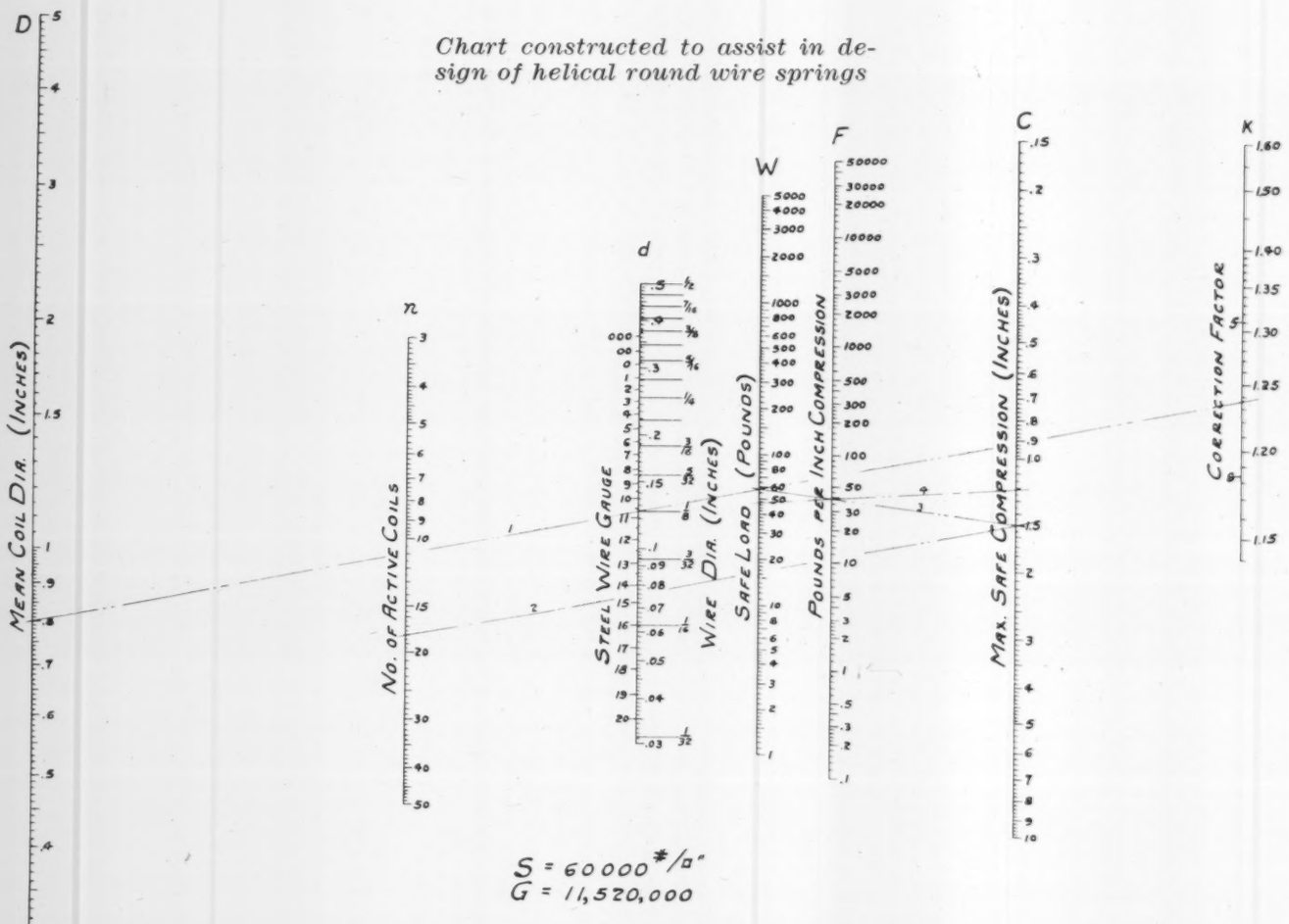
$$\frac{D}{d^3} = \frac{\pi S}{8W} \quad \text{.....(2)}$$

$$W/C = F \quad \text{.....(3)}$$

$$K = \frac{4c-1}{4c-4} + \frac{.615}{c} \quad \text{.....(4)}$$

D = mean coil diameter (inches)
d = wire diameter (inches)
C = maximum safe compression (inches)
n = number of active coils
W = safe load (pounds)
S = torsional stress = 60,000 pounds per square inch
G = torsional modulus of elasticity = 11,520,000
F = pounds per inch compression
K = correction factor
$c = D/d$

Chart constructed to assist in design of helical round wire springs



One straight line drawn through all scales is a complete solution satisfying all equations. However, in order to allow more freedom of design, the pair, C and n, were made independent to the extent that these values may be obtained from any line drawn parallel to the first. This also removes the value of F from the first line to a third line drawn between the W and C scales. Up to this point the results are by the old procedure with the actual maximum stress equal to K times 60,000. Since F is not affected by the correction factor, divide C by K and draw a fourth line through F and the new value of C to intersect the W-scale at its corrected value. Thus only one slide rule computation is required.

For convenience in using the chart, the d-scale is divided in fractions, decimals, and wire gauge. The two figures, five and eight, on the left side of the K-scale are ratios of mean coil diameter to wire diameter which are customary limits unless circumstances require otherwise. Other points may be located upon this line to suit special needs.

Special Variations May Be Used

Individual requirements as to scale limits and particularly the value of stress used would be impossible to meet in one chart, but there is a means of avoiding this difficulty partially. If it should be desired to change the value of S, the scales for n and W are moved up or down the scale line to satisfy the new value. In order to locate the new position of these scales, solve twice for n and W in formulas (1) and (2), using both values of S. These two values then are opposite each other on the scale line and all other divisions are in the same relative position.

In conclusion, we should not be forgetful of two other corrections which Mr. Wahl has shown to have considerable importance. These are due to slight errors in mean coil diameter made in winding the spring and to scratches or surface defects. These are mentioned only to emphasize the fact that more care in manufacture must accompany the extra care in design if the spring is to have the desired properties.

RECIPROCAL relationships between individuals or companies leading to the development of new outlets and new ways of using outlets, as well as new processes, raw materials, etc., are being engineered by Campbell, Peterson & Co., New York, according to a recent bulletin of the company entitled "An Industrial Problem and Its Solution." The company specializes in correlating the efforts of individuals or companies with others and with past achievements in development, patents, and invention. They seek to improve present products and methods, and to develop new products and processes.

Eccentric Spindle Provides Orbital Motion

By Fred A. Firnhaber

ECCENTRICALLY mounted spindles as applied in the design of the planetary type of headstock permit an orbital movement to be transmitted to the cutting tool while the work is held in a stationary position on the table. This type of headstock embodies numerous interesting design features. It is used on a number of internal grinding machines and thread milling machines.

In a grinding machine for internal work, which has a table that travels back and forth

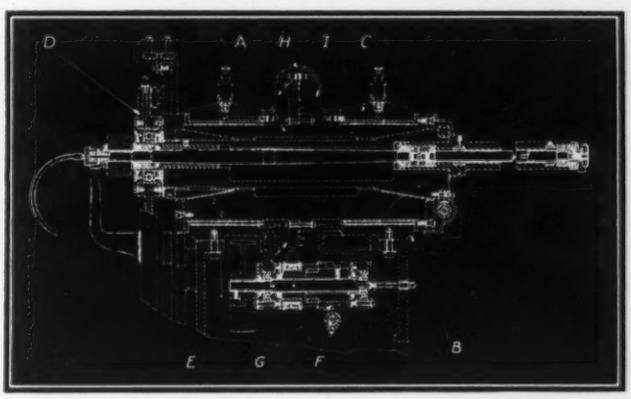


Fig. 1—Eccentric cylinders permit an orbital movement of cutting tool while work is held stationary

parallel to the grinding spindle, the main cylinder A, Fig. 1, is made of cast iron, heat-treated and ground, mounted in the headstock B, and running in bronze bearings which are in cap form. These caps C are set in aligning recesses to insure accurate alignment. They are provided with fine pitch adjusting screws which lock the holding down bolts.

Rotation Maintained at Constant Speed

The rear spindle housing, which carries the grinding wheel spindle driving unit, runs in tapered bearings in the main cylinder with an eccentricity of 1½ inches, giving a total throw of 3 inches. It is made of cast iron, heat-treated and ground. The tapered sleeve which comprises the rear bearing is split to take up any wear that may occur, and is adjusted by a nut which in turn is split and locked in place by a clamping screw. A sleeve is pressed into the rear of this spindle, upon which is mounted a ball bearing which in turn fits the bore of the counterbalanced pantograph arrangement D at the rear

of the machine. It maintains at a constant speed the rotation delivered to the grinding wheel as the driving and driven spindle pulleys run in a planetary motion. On the inside of the sleeve are two ball bearings mounted at the end of the wheel spindle driving unit shaft. The cutting end of the wheel spindle was described in the August, 1930, issue of MACHINE DESIGN under the title "Designing Spindles and Mountings for Extreme Speeds."

On the front end of the rear spindle housing is mounted concentrically a worm gear. The purpose of this gear will be explained later in this article.

Silent Driving Pinion Used

The main cylinder has pressed on it a combination ring spur and bevel gear *E* secured with screws. The spur gear is engaged by a silent type of driving pinion. A clutch *G* of the expanding ring variety is mounted on the shaft which controls the rotation of the main cylinder. This shaft is mounted on ball bearings, and carries, at the left end, the driving pulley. Lubrication is obtained from a grease connection at the right end. Shaft *F* operates the clutch through a yoke controlled by a lever on the front of the machine. A bevel pinion operated by a handwheel engages the bevel gear *E*,

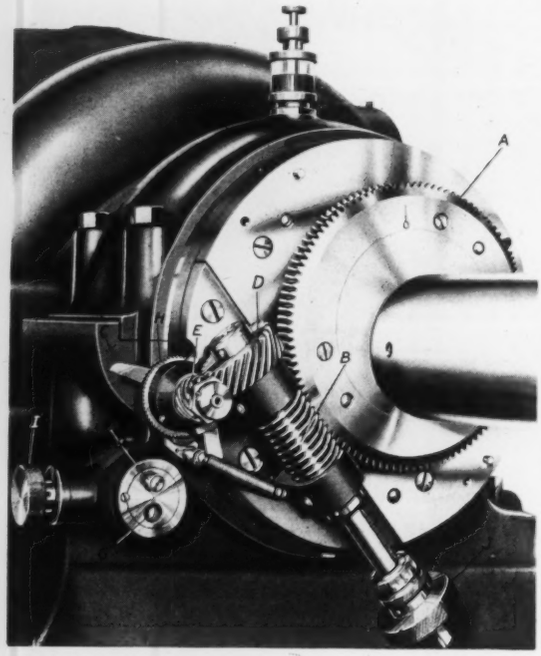


Fig. 2—Operating mechanism of planetary headstock. Control mechanism for regulating eccentricity is adjusted by knob J

facilitating centering, by hand, the grinding wheel in the hole to be ground. The combination gear is housed in a dust proof guard *H*. Oil tubes *I* carry the oil from the pump to glass lubricators on top of the main cylinder bearing caps, through the bearings, and back to the supply tank in the lower part of the headstock.

In the operation of the feed, the main cylinder rotates on its center, while the worm gear *A*, Fig. 2, operates on a center eccentrically ¾-inch from the center of the main cylinder. Thus the center of the wheel spindle, eccentrically ¾-inch from the center of the worm gear, may be brought around to coincide with the center of the main cylinder, pivoting on the center of the gear *A*, and giving no eccentricity whatever. As shown, it is at its maximum eccentricity of 1½ inches or a total throw of 3 inches. The worm *B* which engages the worm gear *A*, actuates the feed and is mounted on an adjustable plate for maintaining proper mesh of worm and worm gear.

On the right end of the worm feed shaft is helical gear *D* meshing with helical gear *E*. As the main cylinder revolves, a ratchet feed lever comes into contact with the roller on the end of the feed control plunger *F* for the coarse feed. It will be seen that this plunger, located nearer the center of rotation than the plunger *G* used for fine feed, will give a greater movement to the ratchet feed lever *C*.

Two Feed Variations Available

Each engagement or revolution increases the eccentric throw enough to enlarge the hole being ground approximately 0.0015-inch. When the lower roller protrudes the feed is approximately 0.0005-inch. This lever is made in the form of a bell crank, upon which is mounted the ratchet feed pawl which engages the ratchet wheel *H* on whose shaft is mounted helical gear *E*.

For quickly increasing or decreasing the eccentric throw, a removable hard crank on the knurled knob *J* may be used. The graduated dial shows the amount of feed obtained per revolution of main cylinder.

The equipment on which this application was made is manufactured by Micro Machine Co., Bettendorf, Ia.

Form St. Louis Welding Society

AT A meeting held recently in the Forest Park hotel, St. Louis, the St. Louis Welding society was formed, and officers elected. This society consists of 65 charter members representing 26 companies in St. Louis, East St. Louis and Madison, Ill. Temporary headquarters of the society were established at 4620 Delmar boulevard, the home of the Hill Equipment Engineering Co. The following were elected officers: president, E. P. Barnes of Moloney Electric Co.; vice president, W. D. Patterson, American School of Welding; secretary and treasurer, Basil N. Osmin, Hill Equipment Engineering Co.

Finding Mechanical Substitutes for Elliptical Gearing

By F. B. Fuller

AN ARTICLE entitled "Designing Elliptical Gearing by Simple Formulas" appeared in the January issue of MACHINE DESIGN. It is the purpose of this discussion to enumerate a few mechanisms, some of them being known and all of them simple in design, which may be employed to give a result more or less similar to that of elliptical gearing. This specification limits them to mechanisms which convert a constant speed rotary motion into a rotary motion with a single maximum and a single minimum velocity, approximately 180 degrees apart in time, and with approximately constant acceleration and deceleration. The limiting ratio of the maximum and minimum attainable velocities to the velocity of the driver will be given.

It will be evident that the mechanisms to be described are but a few chosen from a long list, and that these may be modified or combined with each other, and with still other types, in endless variety. Such variations and combinations easily can become so intricate as to defeat their own purpose, but used in their simpler forms they often can be adopted as substitutes for longer trains of moving parts, for reducing cost, wear, noise, backlash, and power consumption. In a later article the discussion of this general type of transmission mechanism will be extended to examples where acceleration and deceleration are far from constant and in some cases where dwells or short reversals are produced.

IN many instances it is not economical or practical to use elliptical gearing for obtaining variable speed motion. The accompanying article deals with numerous ideas for consideration as substitutes and will be found particularly helpful in such cases. As engineer with the Package Machinery Co., Springfield, Mass., for many years, Mr. Fuller has an excellent background from which to prepare this discussion.

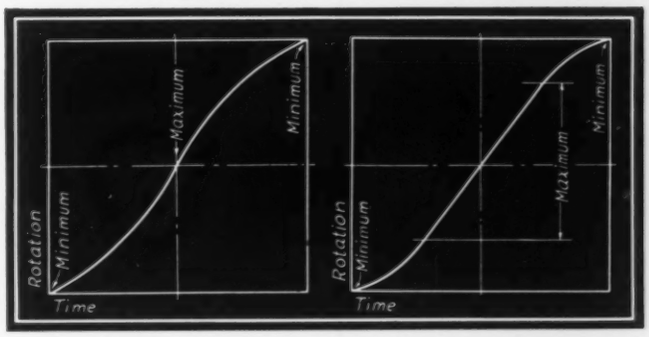


Fig. 1—Time charts indicating speeds of driven shafts under different conditions

The ratio of the velocity of the driven shaft to the velocity of the driver, for brevity, hereinafter will be called "velocity ratio." In case of elliptical gears this ratio, as pointed out in the preceding article, should not greatly exceed two as a maximum, and in all cases the minimum value (which obtains when the driven shaft is moving slowest) is the exact reciprocal of the maximum (when the driven shaft is moving fastest). If, for example, the driven shaft at its maximum speed is turning 3/2 as fast as the driving shaft, it will, 180 degrees of time later, be turning 2/3 as fast as the driving shaft. This is shown in the time chart of Fig. 1 (left) where time in degrees is shown horizontally, and rotation of the driven shaft in degrees vertically. There are no exceptions to this rule, and as a consequence elliptical gears will not always satisfy the requirements.There are times when a considerable reduction of speed is required of the driven shaft at one time in its revolution, but where an equal increase at another point would be prohibitive, and vice versa. Such a condition is shown in the time chart at the right of Fig. 1.

Velocity Ratios Satisfied

Considering the mechanism shown diagrammatically in Fig. 2*A*, this is a perfect substitute for elliptical gears as far as velocity ratios are concerned. The driving and driven members consist of cross arms exactly alike, each bear-

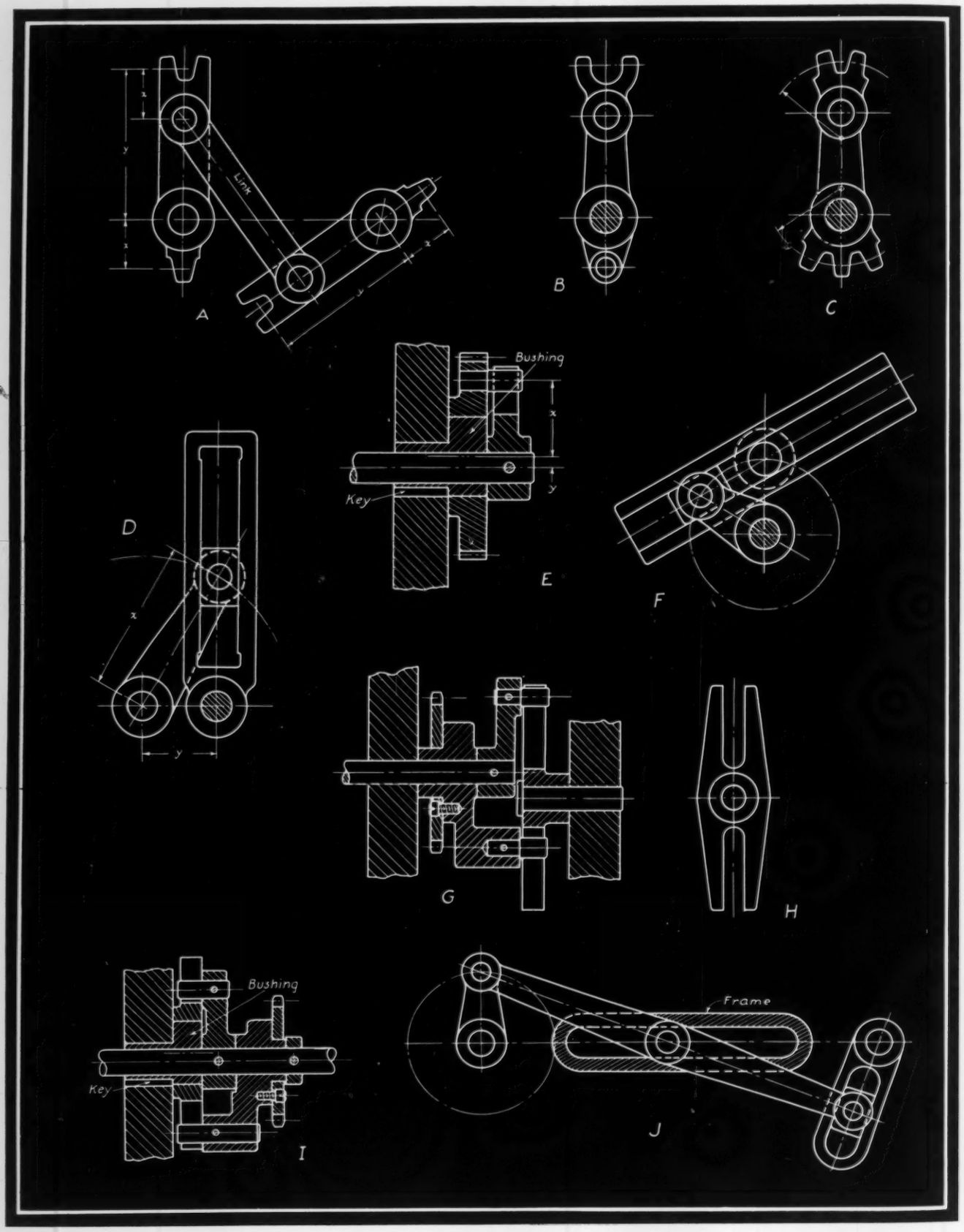


Fig. 2—A—An ideal substitute for elliptical gears. B—Arm designed for roller contact. C— For heavy duty, several teeth can be provided. D—Popular crank and slotted arm mechanism. E—Using an eccentric bushing to give speed variation. F—Substitute for one-to-two internal gears. G—Driving and driven parts, in slotted arm mechanism, mounted on same shaft. H—Detail of cross arm. I—Similar arrangement, but with whole mechanism on one shaft. J—An instance in which driving and driven members are a distance apart. The pin in slotted arm describes a circuitous path

ing a single gear tooth at one end (this may be either the short or the long end) and a corresponding tooth space at the other. These two arms are connected by a plain straight link as shown. The teeth and spaces are necessary to carry the mechanism over the dead centers, of which there otherwise would be two during each revolution. Instead of gear teeth it sometimes is easier to use a round pin (preferably with roller) at one end of each arm, with a corresponding fork to receive it at the other end. This latter method is nearly as accurate as the use of teeth providing the slot in the fork is rather shallow, as shown in Fig. 2*B*.

Require Gear Teeth for High Speeds

If the driven shaft has to perform hard work when near its maximum speed, gear teeth should be used, and several teeth cut on each arm, as in Fig. 2*C*, from a pair of centers. Neither of these will be the shaft center, but rather centers calculated as for cutting teeth on the end quadrants of elliptical gears (see article in January issue). The reason for this is that the power is transferred by the link at an unfavorable angle just before and just after the engagement of the roller and slot, as can be seen in the diagram. The distance from the geometric middle of the two arms to the shaft center must be the same for both arms, and this distance determines the velocity ratio, which is: Maximum y/x, minimum x/y. This ratio may be varied over a considerably greater range than with elliptical gears, on account of tooth interference experienced with the latter when high ratios are attempted. The theoretical limits of the velocity ratios, as with elliptical gears, are: Maximum-infinite, minimum-zero, which limits of course must not be approached too closely.

Each end of the link should be connected to a point the same distance from one end of the arm as the shaft center is from the other end, the "end" being at the pitch line of the teeth, or the center of the pin and roll. The length of the link must be exactly the same as the center distance of the shafts.

Velocity Ratios Different

There is a simple device which is distinctly different from the foregoing in its velocity ratios. It is the well known crank and slotted arm mechanism. It bears the same analogy to a pair of internal gears, or internal genevas, as the so called "shaper motion" bears to external gears and external genevas. Either the crank may be the driver or, in the inverted form, the slotted arm. The velocity ratios and their limits are distinctly different in the two cases. Fig. 2*D* illustrates it in its simplest form. As shown, the arms must be on the ends of their respective shafts, and the two shafts must have bearings in different frames or brackets, since each arm in its travel passes across the center of the other shaft.

It is not difficult, however, to journal both shafts in the same frame. This is done by the use of an eccentric bushing around one of the shafts. In this case one of the arms must revolve on the outside of this bushing, and to receive or transmit its power through a directly connected gear or sprocket, as shown in Fig. 2*E*. The slot in the arm always must be long enough to encompass the crank pin or block in its extreme positions; and the crank itself must be enough longer than the distance between the centers of the two shafts to allow the crank pin and block to pass outside of the other shaft.

When the crank drives the slotted arm, the velocity ratio is: Maximum, $x/(x\text{-}y)$, minimum,

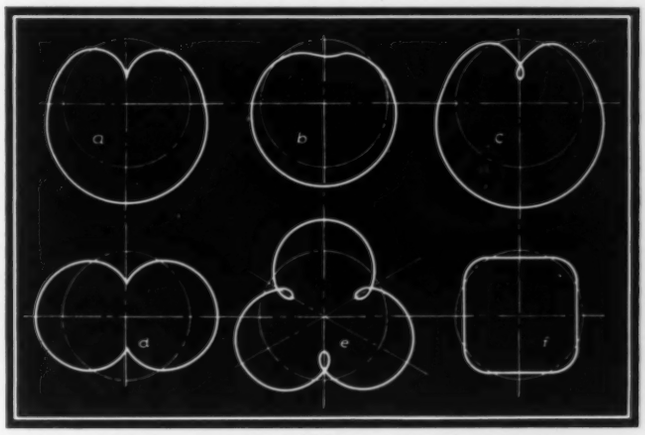


Fig. 3—Shapes of path of pin obtainable with arrangement shown in Fig. 2-J

$x/(x+y)$. The limits of these ratios are: Maximum, infinite, minimum, one-half. If the slotted arm drives the crank, the velocity ratio is: Maximum, $(x+y)/x$, minimum $(x\text{-}y)/x$, and the limits of the ratios are: Maximum two, minimum, zero. In all cases, but this time on account of obvious structural difficulties, the theoretical limits of the velocity ratios cannot too closely be approached.

It will be seen that these velocity ratios differ greatly from those of elliptical gears, or from those of the mechanism shown in Fig. 2*A*, and this fact often will prove important. It enables the designer to accelerate to high speed a moving part, and return it to normal speed again, without the waste of time which an unnecessary reciprocal deceleration to low speed at another point in the cycle would necessitate. Or, using the inverted form where the slotted arm drives the crank, he may obtain a very slow point in the travel of a moving part without a corresponding acceleration to high speed when the latter is unnecessary, and would result only in excessive wear and vibration.

As an interesting diversion, Fig. 2*F* shows a device which is a substitute, not for elliptical gears, but for one-to-two internal gears. The

crank must be the driver, and is exactly the same length as the center distance between the two shafts. The slotted driven arm extends equally in opposite directions from the driven shaft. The crank will drive the slotted arm at a constant speed, in the same direction, and at one-half the crankshaft velocity. There will be no dead center, but at the point where the crank and slotted arm are perpendicular to each other the latter is in a dangerously indefinite position. This should be avoided by some sort of momentary locking device, such as small pins or rollers on the two members which just clear each other in passing at this position.

The crank and slotted arm principle can be repeated, in the same unit, to allow the driving and driven members to rotate on the same

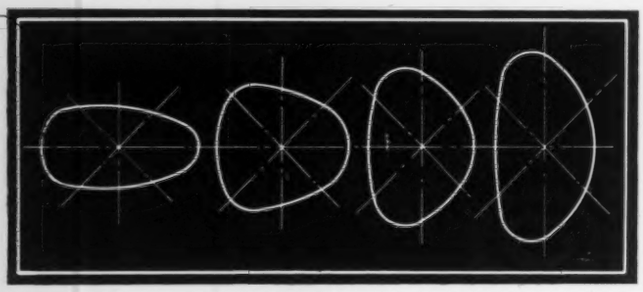


Fig. 4—Various changes in velocity can be obtained by moving center of fulcrum

center. This is illustrated in Fig. 2*G*. The driving and driven members are both cranks, which may or may not be of the same length, and each crank pin rides in the slot of the long, straight, slotted cross arm (shown in more detail in Fig. 2*H*). This slotted arm must be in a separate frame or bracket and is pivoted eccentric to the shaft center. One of the cranks is pinned or keyed to the shaft, the other crank having a direct connected gear or sprocket through which to receive or transmit the power; and either crank may be the driver.

Cranks Driven at Varying Speeds

It is possible to make the intermediate arm the driver, in which case the two cranks will be driven at varying speeds, one attaining its maximum at the moment the other attains its minimum, and vice versa. By making the two halves of the intermediate arm at some angle with each other, other than 180 degrees, the time between the maximum velocity of one crank and that of the other can be changed to other than 180 degrees. The intermediate arm may be varied by having pins at each end instead of slots, in which case the cranks will become slotted arms; or the intermediate arm may have one slot and one driving pin, and the driving and driven members made to correspond. Imagination can run riot with the possibilities, for there are, obviously, a great variety of combinations, and each will have its own maximum and minimum velocity ratio. In fact the only way to determine the velocity ratios of the whole unit is to calculate them between the driving and intermediate members, and then between the intermediate and driven members; and the desired ratios are the products of these two maxima and minima. Moreover, the limit of these ratios are not confined to the limits of the two elements which it combines, and therefore considerably more latitude is offered than with either element alone.

A still more interesting variation is shown in Fig. 2*I*. In this form the driving and the driven members are on the same center, and the intermediate member does not require a separate bracket. In fact the whole mechanism can be mounted in the middle of a long shaft without interference. This is accomplished by the use of a stationary eccentric bushing, as used in a previous example. The velocity ratios and their theoretical limits are to be calculated as explained in the preceding paragraph.

Mechanisms Are Basically Similar

Each of the mechanisms described above, with the exception of the first, consists, in essence, of the action between a revolving, straight, slotted arm and a driving (or driven) pin riding in the slot which describes a perfect circle eccentric to the slotted arm shaft. There are a number of devices of a different type from this which sometimes can be used with equal facility to give approximately uniform acceleration and deceleration, but as their chief value lies in the additional possibilities of variable and peculiar accelerations, dwells and reversals, these will be left for discussion in the later article. There are two examples, however, which it might be well to take up at this time. These two are different from those described above in that the driving (or driven) pin does not describe a circle.

In the first example the driving and driven shafts are separated a moderate distance, in fact it is under this condition that a device of this sort is most valuable. The driving member is a crank and the driven a slotted arm; or these two elements may be reversed. Motion is transmitted from one to the other by means of a long straight link or beam, which slides at its center along a slot approximately in the line of shaft centers and at the same time rocks on its own center, as will be understood by referring to Fig. 2*J*. One end of this beam is connected directly to the crank pin. The other end carries a pin and block which latter rides in the slotted arm. This last mentioned pin describes a circuitous path whose shape may differ greatly from a circle, and depends upon the length of the crank, the location of the stationary slotted guide, and the distance from the sliding middle point of the beam to each of its end pins. Fig. 3 shows four distinctly different

(*Concluded on Page* 64)

Metal Creep at High Temperatures

By P. G. McVetty

IN THE field of design today many important advances are waiting only for the development of reliable metals which may be depended upon to carry relatively high working stresses at temperatures from 750 to 1200 degrees Fahr. In many cases suitable materials are now available, but it is necessary to choose the one best adapted to the particular application and to assign to it a safe working stress. The latter requires consideration of corrosion and erosion which may reduce the cross section of metal carrying the load, and metallurgical changes within the material which may change its physical properties during its life of service.

One of the difficulties in this connection is the creep of metals, which may be defined as the plastic deformation or permanent set which results from the continued application of stress at elevated temperatures.

Tests Must Be Limited

Tests to determine creep must be limited in time, and much depends upon the extrapolation of curves to times equivalent to the expected life of the material in service. It therefore is of great importance to develop rational concepts of the fundamental nature of creep phenomena. A better definition of what creep actually is, as differentiated from what it does is that creep is the outward manifestation of the balance in the destruction of strain hardening by thermal influence and its recreation by further slip. This indicates that creep is the net effect of two opposing forces.

If a specimen is stretched at normal temperature, it is known that plastic deformation results from slip along crystallographic planes which coincide with planes of maximum shear least favorably situated with respect to the principal stress. According to slip-interference theory, slip is opposed at the grain boundaries, with the result that metals increase in strength as the grain size diminishes. This theory thus accounts for the fact that metals at normal temperatures are strengthened by treatments which reduce the grain size. At elevated temperatures, however, there is now some evidence that metals are weakened by reducing the grain size. This may be due to the relative value of material within and between the crystals.

In the present state of knowledge it is impossible to say whether creep is due to slip within the crystals, to plastic flow of the intercrystalline material, or to a combination of the two.

Age Hardening Reduces Creep Rate

The greater the amount of cold work, the lower will be the temperature which will cause softening or the shorter will be the time required to produce softening at a given temperature. Heat-treated materials also have a tendency to be unstable if subjected to long exposure to stress at elevated temperatures. Another metallurgical change which has a great influence on creep tests is the age hardening of certain alloys. This may not only reduce the creep rate to zero, but actually cause contraction of the test specimen. This phenomenon is due to precipitation of certain constituents, accompanied by increase in strength and decrease in ductility.

To a certain extent the designer is at the mercy of the metallurgist, as so much depends upon the treatment of the metal in making it ready for service. A thorough knowledge of the action of various materials under the combined influence of stress, temperature, and time is particularly important. The collection of reliable creep data for the numerous metals and alloys now available will require many years. In the meantime it is probable that extensive service applications will be made without having complete data on creep phenomena. The success or failure of design may hinge upon these details.

IN the early days of design it was sufficient to know the tensile strength of the material, and all other considerations were covered by a generous factor of safety. Today, however, a new factor of extreme importance is the creep of metals at elevated temperatures. This abstract is from a paper presented at the Western Metal Congress, San Francisco, by P. G. McVetty, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Editorial

Create Distinctive Designs—and Speed Up Recovery!

THE business depression has continued longer than anyone anticipated. Many manufacturers who in its early stages were determined to keep up their design activities, have been forced by acute necessity to reconsider. In a number of important plants the work of engineering departments has been restricted.

This is unfortunate because now is the time when sound engineering ideas are needed most urgently. In no line of business is the market so dead but what an article of exceptional merit can be sold. Today the distinctive wins out over the common-place every time.

If the manufacturer of a unit for resale—for instance a motor, transmission, bearing, etc.—can offer his customers a product so distinctive in efficiency, scope of performance, price or other qualification that it lifts this unit above comparison with others—that manufacturer is going to win the cream of the business. And the manufacturer who gets the jump on his competitors during this period of hard times is likely to carry his advantage well into the approaching era of prosperity.

Distinctiveness in machine design must come primarily from ideas, and ideas in turn emanate most logically from an alert engineering staff that is alive to sales opportunities. No less an authority than Charles F. Kettering declared recently that the thing most needed in the engineering profession today is ideas.

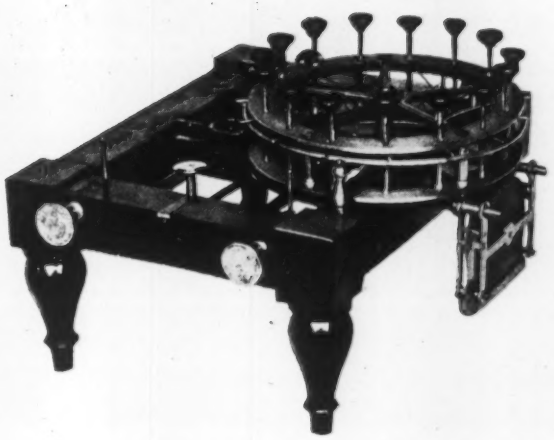
It is to be hoped that the managements of companies which have curtailed design activities will manage to find some way of reinstating this work. In many cases it is their main hope for salvation.

Interchanging Design Ideas

DISTINCTLY progressive—and a step with which we are in hearty accord—is the inauguration of a clearing house for machine design data formulated recently among the faculty of engineering colleges.

Fostering the interchange of ideas as necessarily it must, the clearing house will fill a pressing need. Too long have many professors of machine design been constricted to devote themselves to their specific tasks without the advantages resulting from broad contacts and co-operation.

The example set by these teachers of the rising generation of designers is one that well could be followed more closely by present-day members of the profession in industry. Greater advantage should be taken by them of the opportunities for interchange of thought presented in discussions at meetings of engineering societies and in contributions to the technical press.



Developments in Typewriter Design

Photos, courtesy Royal Typewriter Co.

While it is impossible to depict here all stages of typewriter evolution, these illustrations serve to indicate the progress made. In oval is a model of 1843, a distinct advance over the first typographer of record patented in 1829. Upper right shows piano keyboard machine with first up-strike pivoted type bar, 1857. Machine at left was developed 1878 and in center is one of today's models.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Friction Drives for Drums

To the Editor:

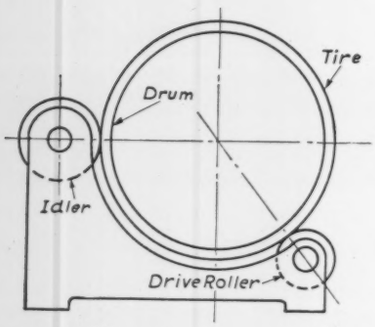
AS AN "Old School" machine designer, reading the interesting article by Mr. W. A. Rosenberger on loaded drums in the December issue of MACHINE DESIGN, the thought came to me—why not design an arrangement of this kind like the one shown in the accompanying sketch so that:

1—No calculation would be necessary except bearing loads.

2—The friction coefficient between drive roller and tire need not be considered.

3—The distance from the center of the drum and from the center of gravity of the drum to the center of the idler roll always would be a maximum.

4—The tire diameter need not be considered.



Friction drive arrangement requires minimum design calculations

5—The eccentricity of the load need not be considered.

6—The idler friction or idler diameters need not be considered.

7—The angle from the vertical through the center of the drum and a line through the center of the drum and the center of the idler is always the maximum of 90 degrees.

In this type of drive a maximum tractive force and load can be provided on the drive roller by putting the idler rollers on short stationary shafts (as suggested in Mr. Rosenberger's article) on the horizontal center-line of the drum, either side of the door opening.

—G. R. RICHARDS,
Elizabeth, N. J.

To the Editor:

ON PAGE 43 of the December issue of MACHINE DESIGN, is published an interesting treatise on friction drives for drums, and methods of correcting slippage troubles in the drive. It would seem that while it is possible to go into a good deal of hair splitting and theorizing on the subject, there really is no particular advantage in having a friction drive. And wherever a friction drive does not efficiently accomplish its purpose, why not put a ring gear on the drum, and a pinion on the drive shaft?

The writer had some experience with drums of this type used as pebble mills for grinding enamel. The smaller sizes generally were hung on trunnion bearings, and driven in batteries by belt from a line shaft, while the larger and heavier units always were supported on rollers as illustrated by the author of the article mentioned, and driven positively by a gear and pinion or chain.

Designers often get into the fallacy of trying to accomplish a certain thing in a certain way because the two always were associated. By getting away from the original method, the purpose often is accomplished much easier and better.

—EDWARD HELLER,
Cleveland.

Tabulation of Drawings

To the Editor:

EVERY machine manufacturer designs many new and special parts for use on some particular product and later finds them applicable to other designs. A common difficulty is that

data covering such details are not always available in the form of standards sheets, and the time and energy required to locate drawings of parts which possibly may be used is frequently more costly than the work of making new drawings. Thus within a few years there exists much unnecessary duplication of drawings, tools and parts.

The value of readily available data on such machine elements was recognized long ago by Fairbanks, Morse & Co., and their present system of tabulated drawings was evolved as a step in simplification.

The accompanying illustration shows a drawing of special parts which could be used on various products. Only one figure is drawn on a sheet, and the difference between successive items is in material or size but not in general shape. The title states which features are unvarying or limited in variation. The numbers of the bills of material upon which each part is used are shown, as the information is useful in consideration of changes.

Symbols are arranged consecutively in the proper column without any omissions. These for the sheet of parts the next size larger than the one shown are 18NS16A, 18NS16B, etc.

Files Arranged Conveniently

Blueprints are placed in shop departments and also in an alphabetically arranged file in the drafting room. When a draftsman desires to use a washer other than the national standard type, he refers to the file of washer blueprints. Turning to the sheet which shows those characteristics he needs, he selects a part, the symbol of which he incorporates in the bill of drawing, which is filed by its symbol in a fireproof vault. If he finds no suitable part, he designs a new one and adds the data to the proper drawing, or if necessary, he makes a new drawing covering another classification. Each addition decreases the probable necessity for another.

Parts to which this can be applied are: pins, gears, rods, bushings, collars, rollers, springs, special studs, screws, washers, and others of a similar nature.

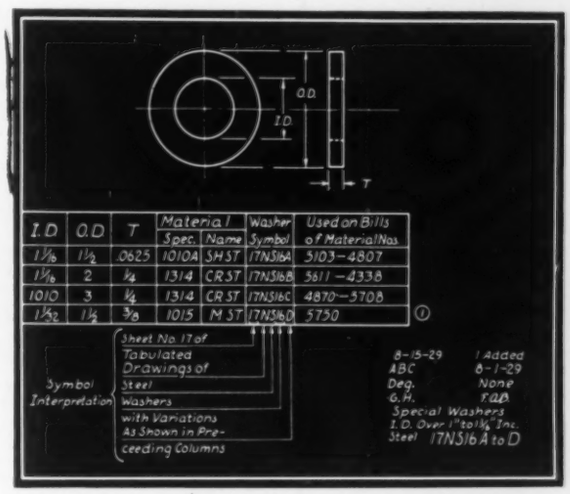
Savings made by this method may be classified as follows:

1. Reduction in the number of machine elements is accomplished, resulting in lower costs and the many other benefits of simplified practice. The tool expense for a special washer, for instance is from $50 to $150. The reduction in cost due to increased production of an article is known to all manufacturers.

2. When additions to tabulated drawings are necessary, roughly half the drafting time is saved, because one figure serves for several times.

3. The number of drawings to be handled is less than if only one part were drawn on a sheet, and the confusion resulting from having several unlike pieces on one sheet (as was once universal practice) is absent.

4. Data is available for study in standardization and further simplification. When opportunity offers, a series of sizes varying in accordance with some preferred number system can be designed for future use, and standards sheets inaugurated.



Sample specification sheet indicating procedure used in preparing standards

—Fred L. Burns,
New York

This Machine Age!

To the Editor:

MAY I suggest a sidelight on the all-important question of your interesting leading article in the March issue of Machine Design on the Machine Age, and introduce it with an anecdote?

When the trans-Atlantic telephone service was inaugurated the American Telephone and Telegraph Co. was represented in England by a man who, though born and educated in England, had acquired a decidedly American attitude. He felt that so important a forward step should be the occasion for ceremonies that would attract widespread attention, and in his attempt to arrange suitable festivities he called on the chancellor of a great British university. "Would the chancellor consent to be entertained at a luncheon, together with other men of note? And would he during the course of the meal, converse by telephone with the president of one of the American

(*Concluded on Page* 90)

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

AUTOMOBILE engine designs and the initiation of radical improvements in the principles underlying those designs have been the all-absorbing interests in the career of Col. Elbert J. Hall, vice president in charge of engineering of the recently formed De Vaux-Hall Motors Corp. Colonel Hall entered the employ of Pioneer Automobile Co., San Francisco, in 1904 and thus began his connection with the automotive industry. Later he opened a mechanical shop where he built an automobile for his own use.

The Hall-Scott Motor Co., Berkley, Calif., was formed with Bert Scott in 1909. From that time until the beginning of the World war, Colonel Hall was engaged in the design and production of motors for automobiles, airplanes, marine applications, railroad gasoline motor coaches, and tractors. He entered the military service as colonel at the start of the war, and soon was called into consultation on the design of an improved airplane motor. His achievements in co-operation with others in this field resulted in the Liberty motor and the personal award of the Distinguished Service Medal. Henry Ford engaged him as consulting engineer in 1920-1921, while in 1922 he designed a new six-cylinder motor for Buick. In 1930 Colonel Hall joined with Norman de Vaux to form the De Vaux-Hall Motors Corp.

SINCE the early days of radio, Dr. Alfred N. Goldsmith, recently appointed to the board of the American Standards association, has been closely associated with that field. Throughout its development he has remained a specialist in the industrial utilization of electro-magnetic waves. He conducted the radio research laboratory and taught electrical engineering in the College of the City of New York from 1907 to 1917. At that time he became consulting engineer for the General Electric Co., and later director of research for the Marconi Wireless Telegraph Co. of America.

In 1919 he joined the Radio Corp. of America, holding the post of chief broadcast engineer until recent years, when he was appointed vice president and general engineer. Dr. Goldsmith has been closely associated with radio television development, both in the transmitting and receiving fields. He is a specialist in broadcasting problems, including high power transmission and short wave operation.

Dr. Goldsmith is a Fellow and past president of Institute of Radio Engineers; Fellow of American Institute of Electrical Engineers, American Association for the Advancement of Science, Acoustical Society of America, and American Physical society; honorary member of Radio Club of America; and active member of Society of Motion Picture engineers and other technical organizations.

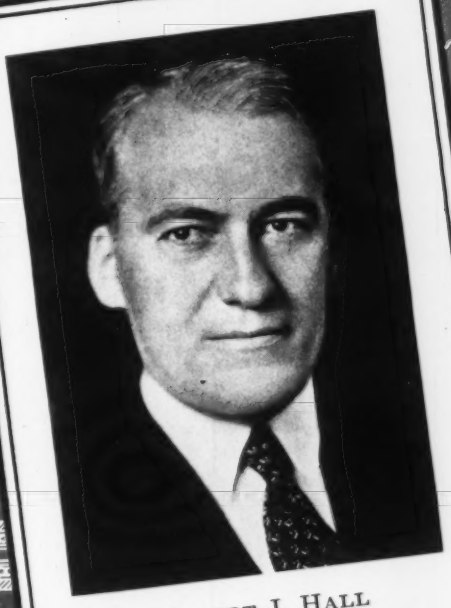
ADDING to a career already made distinguished by the award of numerous medals and degrees, the Franklin Medal for 1931 will be conferred on Dr. Willis R. Whitney, vice president and director of research, General Electric Co. Dr. Whitney, inventor of one of the earliest improved incandescent lamps and the author of numerous scientific papers, has been almost wholly engaged in research work. The G. E. laboratory, the credit for the development of which belongs to him, has uncovered many new fields of application for electricity; and has produced many new inventions.

Dr. Whitney is a graduate of Massachusetts Institute of Technology, 1890, and the University of Leipzig where he received a Ph. D. degree. He was an instructor in chemistry with his alma mater at Cambridge until 1901, at which time he came to the General Electric Co. From 1901 to 1904 he also continued his teaching work, but since that time has been wholly engaged with the laboratory.

He was awarded the Willard Gibbs medal, 1916, the Chandler Medal, 1920, and the Perkin Medal, 1921. His society connections include: past president, American Chemical society; honorary member, American Society for Steel Treating; fellow, American Academy of Arts and Sciences; fellow American Association for the Advancement of Science; Institute of Metals, England, and others.

FOR his numerous designs and improvements of devices and machinery for smelting, refining and rolling copper, William H. Peirce, vice president, American Smelting & Refining Co., has been awarded the James Douglas medal for

Leaders in Design, Engineering and Research



ELBERT J. HALL

ALFRED N. GOLDSMITH

WILLIS R. WHITNEY

WILLIAM H. PEIRCE

1931 of the American Institute of Mining and Metallurgical Engineers. After graduation from Stevens Institute of Technology, with a degree in mechanical engineering, Mr. Peirce served the Pennsylvania, and Chicago, Burlington & Quincy railroads as mechanical engineer, did construction work for the Edison companies, and then went back to his native city of Baltimore to take up his career with the famous Baltimore Smelting & Rolling Co.

With this company he occupied the posts successively of assistant manager, manager and president. To this plant, as well as the one at Perth Amboy, N. J., he still devotes personal attention, although his present position brings him a wider range of responsibilities. Mr. Peirce early developed a talent for finding the way to make metallurgical processes operative on a plant scale and, alone or in co-operation with metallurgists, he has made notable contributions to the art of mechanical casting, electrolytic refining, and copper converting in particular. In the latter field the Smith-Peirce basic converter has long stood supreme.

He is a member of American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, and Sigma Chi fraternity.

* * *

R. W. Owens, manager of industrial motor engineering, recently was made general manager of industrial engineering and will represent S. M. Kintner in a group of departments of Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Mr. Owens has been with Westinghouse since he graduated from the University of Illinois in 1915. Most of his work has been in connection with motor engineering and his new position will give him supervision of industrial motor, control, small motor and industrial heating engineering.

* * *

Dr. Ralph B. Kennard, formerly head of the physics department, Robert college, Istambul, has been appointed a research associate of the bureau of standards, for research work covering the fundamental problems of heat transfer between solids and liquids. This work is in accordance with the provisions of the Luther B. McMillan fellowship established by Johns-Manville Corp., Chicago.

* * *

H. R. Krueger has been elected vice president in charge of engineering of Ex-Cell-O Aircraft & Tool Corp., Detroit. Mr. Krueger has been active in the development of multiple equipment used in many industries.

* * *

Elber E. Yakes has been advanced by the Worthington Pump & Machinery Corp., Harrison, N. J., to the position of vice president, in charge of manufacturing and engineering. Michael Riesner of the Cincinnati division has been selected by the company for special work on the design and development of new and improved products. Mr. Riesner became chief engineer of the Cincinnati works in 1911.

* * *

O. D. Treiber, has become chief engineer of the Diesel division, Hercules Motor Corp., Canton, O.

* * *

W. W. Smith has been appointed executive engineer in charge of experimental production for the Studebaker Corp., South Bend, Ind.

* * *

W. Lawrence LePage has been made chief engineer of the Kellett Aircraft Corp., Philadelphia, succeeding F. E. Seiler.

* * *

Lawrence C. Moore has been appointed agricultural engineer of the Portland General Electric Co., Portland, Oreg.

* * *

Edward N. Hurley Jr., president of the Electric Household Utilities Corp., Chicago, has been re-elected president of the American Washing Machine Manufacturer's association.

* * *

P. S. Dickey, who for several years has specialized in automatic combustion control problems for the Bailey Meter Co., Cleveland, has been appointed research engineer.

* * *

P. B. Eaton, associate professor of Lafayette college, Easton, Pa., recently was promoted to full professorship in the department of mechanical engineering.

* * *

Frederick W. Mierke, for the past two years turbine engineer with the General Electric Co., Schenectady, N. Y., is now with the engineering department of Beloit Iron Works, Beloit, Wis.

* * *

R. R. Weddell, formerly chief engineer of C. K. Tool Co., Shelton, Conn., has been appointed sales manager, and has been succeeded by E. Reaney.

* * *

David Sicklesteel, formerly chief engineer with the Detroit Gear & Machine Co., has joined the engineering staff of the Products division, General Motors Corp., Muncie, Ind.

* * *

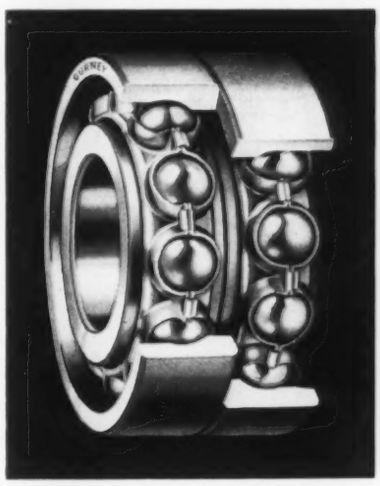
J. B. MacNeill has been appointed by Westinghouse Electric & Mfg. Co., as general manager of distribution engineering with headquarters at East Pittsburgh, Pa.

* * *

Dr. Harry A. Curtis, chairman of the division of chemistry and chemical technology of the

Machining to .001" accuracy for 13 years — *without an adjustment*

THE year was 1916. The facilities of every shop, dock and factory were being taxed to the utmost with war time production. It was during this period that a prominent Machine Tool Manufacturer received orders involving considerable accurate machining. Close tolerances plus the extreme size and weight of this work required the building of special heavy duty turret lathes. One thing in particular puzzled this manufacturer—"spindle construction." Control of spindle accuracy he well knew lay in the bearings. Experience forewarned that plain bearings in this case were out of the question. There seemed to be but one answer—an anti-friction bearing.



The Gurney reputation for successfully applying Ball Bearings to difficult industrial applications—even at this early stage of the industry—influenced this manufacturer to place his spindle problem before Gurney Engineers.

With a full set of blueprints and specifications, Gurney Engineers set to work. First an analysis. What this manufacturer required was a bearing of large radial and thrust load capacity—that would support the spindle rigidly—that would prevent chatter under full working load and maintain close tolerances in the face of continuous service.

A few weeks later six sets of Gurney Duplex Ball Bearings were delivered to the manufacturer along with mounting and housing data. "This is the first time", Gurney Engineers wrote, "that we have ever recommended the Duplex bearing for spindle service—we feel certain it will prove satisfactory—however, should trouble develop, please advise."

But trouble did not develop. The bearings were installed in the lathes and placed in operation in November, 1916. The remarkable performance record established by these bearings is best expressed by the following statements taken from a letter voluntarily written to us by this manufacturer on March 21st, 1930:

"All of these six machines have received very hard service. Some of that time they were running day and night. Only one spindle has ever been adjusted—These machines can swing work up to 24". Our working limits are .001" on the O. D. and I. D. as well as for facing at this writing, SO THE ACCURACY OF THESE MACHINES HAS NOT DIMINISHED OVER THIS PERIOD OF 13 YEARS."

This is the bearing that Gurney Engineers have continually recommended for spindle service. It is no longer an experiment as the Gurney Duplex has proved its merit many times. From no other source can Machine Tool Manufacturers secure a spindle bearing with such performance records to prove its rigidity—capacity—and permanent accuracy.

We suggest that Machine Tool Manufacturers who are interested in better spindle performance write for full facts regarding Gurney Duplex Ball Bearings. Our Engineering Department will be pleased to furnish all the required information at your request. GURNEY BALL BEARING DIVISION
MARLIN-ROCKWELL CORPORATION JAMESTOWN, N. Y.

GURNEY BALL BEARINGS

National Research council, has been appointed chief of the research laboratories of the Vacuum Oil Co., New York. One of his most notable achievements was the nitrogen survey made for the United States department of commerce in 1923, the results of which received World-wide recognition.

* * *

Clare H. Draper has resigned from active charge of the patent and experimental departments of the Draper Corp., Hopedale, Mass., after many years devoted to the development of textile machinery.

* * *

Dr. Robert C. Williams has been appointed a member of the technical staff of the Battelle Memorial institute, Columbus, O. He is a graduate of Oberlin college and for two years past has been engaged in an industrial rubber research.

* * *

Clyde B. Mitchella has been appointed as general manager of Adamson Machine Co., Akron, O. For the past five years, Mr. Mitchella has been chief engineer for the Republic Rubber Co., Youngstown, O. He is a graduate of Case School of Applied Science, Cleveland.

* * *

John Southern, for many years engaged in engineering, manufacturing and sales work in the United States with the American Rolls Royce plant, Springfield, Mass., has been appointed general manager of Worthington-Simpson, Ltd., of Great Britain.

Obituaries

ALEXANDER LUCHARS, president, Industrial Press, and publisher of *Machinery* died of pneumonia at his home in Upper Montclair, N. J. Mr. Luchars founded *Machinery* in 1894, which venture was preceded in 1889 by the establishment of the Industrial Press. In 1919 the secretary of commerce appointed Mr. Luchars to study the machinery markets in Europe. He was at one time governor of the Machinery club of New York.

* * *

LUIGI LUIGGI, 74, senator of the Kingdom of Italy, noted Italian engineer and a recipient of the American Society of Mechanical Engineers' Fiftieth Anniversary medal, died recently of apoplexy. Dr. Luiggi, who experienced a long and varied career in engineering all over the world, was honorary president of the National Council of Public Works of Italy, professor of hydraulic and maritime engineering at the Royal University of Rome, consulting engineer for harbors, rivers and canals, and had served as inspector general of the Royal Corps of Civil Engineers.

Mechanical Substitutes for Elliptical Gearing

(*Concluded from Page* 54)

shapes which can be obtained, the exact results being most easily determined by trial with a model made of stiff cardboard and thumb tacks.

Velocity of the driven member will vary according to the shape of the path of this pin, even if the slotted arm is journalled near the middle of the path. It will be seen readily that accelerations and decelerations in a multitude of varieties can be obtained by locating the shaft at positions distinctly off center within this path.

In the last example the pin generates a one-cusped prolate epitrochoid, which sometimes is a useful curve for the machine designer. The well-known cardioid curve (See Fig. 4*a*) is generated by a pin in the pitch circle of a planetary gear revolving around a central "sun" gear of equal size. Such a device is simple in construction. When this pin is located inside the pitch circle, its locus is a prolate epitrochoid (see *b* in Fig. 4) and when it is outside the pitch circle (that is, in an arm fastened to the planetary gear and longer than the gear's radius) its locus is a curtate epitrochoid (*c* in Fig. 4) and will include a loop at one point as shown. Two, three, etc., indentations, "nodes," or loops can be produced by making the planetary gear one-half, one-third, etc., as large as the central fixed gear (see *d*, *e*, and *f* in Fig. 4).

It is evident that if the pin which generates these interesting curves rides in the slot of a driven arm revolving on the center of the stationary gear the velocity of this driven arm will vary in a way that sometimes can be put to good use. The writer has used this device to produce a slow spot in the transporter of a large bundle-wrapping machine. The curve generated was that shown at *b* in Fig. 4 and a minimum velocity for the transporter of one-half average was obtained at one point in the cycle, while at no time did the maximum velocity exceed five-fourths average.

If the exact requirements cannot be obtained otherwise, the slotted arm may be journalled eccentric to the central stationary gear. This greatly widens the possibilities, but is a little more difficult in construction.

The curves *a*, *c*, *d*, *e* and *f* in Fig. 4 will produce instantaneous dwells, multiple dwells, reversals, etc., which are beyond the scope of this article, but are mentioned in passing to call attention to the great variety of effects that can be produced with this simple and substantial device, and to arouse the interest of the designer who thinks only in terms of elliptical gears and genevas.

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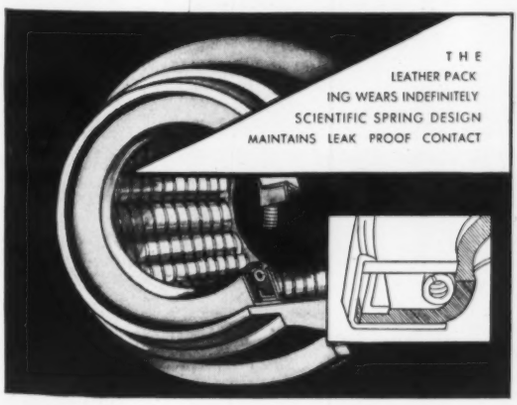
MORE THAN 50 YEARS OF RESEARCH

The heart of an oil seal is its leather. The right *leather* efficiently placed in a seal of correct design is your guarantee of performance. PERFECT OIL RETAINERS are manufactured by the world's largest producers of industrial leathers. More than 50 years of research are behind it. It is the *only* seal on the market today with a leather packing member that is time-tested and proved.

PERFECT OIL RETAINERS are both efficient and economical. Delivered as a compact, self-contained unit, they are easily and quickly installed by a simple press fitting operation. They will effectively seal lubricant leaks and protect the bearings in your product. Our engineers will gladly cooperate with you without obligation.



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IF MADE OF LEATHER FOR MECHANICAL PURPOSES WE MAKE IT

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

APPLICATION of gum to sheets or strips for a variety of purposes from pasting on windows for display to forming a sealing surface for wrapping is performed efficiently on an improved machine patented by Edgar W. Reutener, Bay Village, O., number 1,795,409. The patent, assigned to Wm. A. Howe Co., Cleveland, specifically covers a method for applying the gum to a predetermined group of spots or strips.

A base or support 1, Fig. 1, has journaled on it a shaft 2 on which is a roller 3 and ring gears 4. Pivotally mounted on shaft 5 is a bell crank 6 adapted to support an adhesive container 7. This container is shown in dotted lines in position to gum the entire surface, and in solid lines for applying the gum in spots. On container 7 is shaft 8 to which is connected a paste roller 9. On one end of shaft 8 is gear 10 which meshes with gear 4. Also on the container is feed roller 12 which is driven by gears 10, 12*a*, 12*b*. In coating the entire surface, the paper is fed into the roller and engaged by fastening elements. As the roll is rotated a coating of paste is applied by roller 9 feeding from the container.

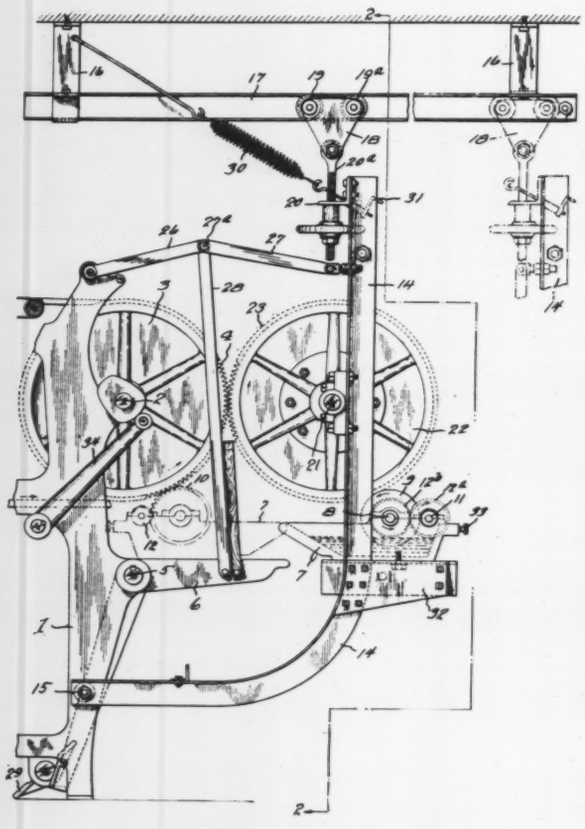


Fig. 1—Machine for applying gum to paper may be adjusted to cover whole surfaces or predetermined spots

For applying the paste to spots or strips of the paper an auxiliary drum 22 is mounted by frame 14 and connecting members so that pressure on the foot lever 29 operating to raise arm 6, push up arm 28 and draw support 14 closer by means of lever 26 and 27 will bring gear 23 in mesh with gear 4. Thus the roller 22 is driven by the same power which drives roller 3. The paste container is placed on support 32 and the paste feed roller is driven by gear 23 through gear 10. On the face of roller 22 is mounted pattern strip 24, Fig. 2, on which are raised portions 25 the only surfaces which will receive the paste. As the sheets or strips are fed through the mechanism the pattern applies the gum to their face.

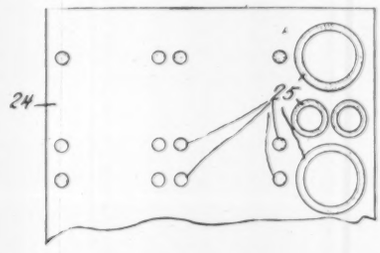


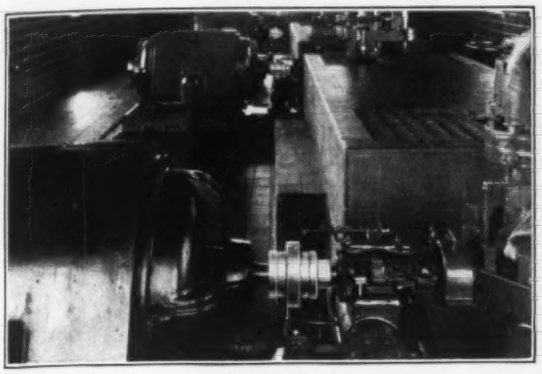
Fig. 2—Pattern sheet arrangement for controlling surface areas to be gummed

MEANS requiring clutch elements, once disengaged, to undergo a relative angular movement of 720 degrees before they can be moved to an operative position, distinguish a clutch recently patented by Anthony D. Gargolinski, Worcester, Mass. Patent number is 1,787,708. This invention is particularly usable on, though not limited to, the Knowles loom, and has been assigned to Crompton & Knowles Loom Works, Worcester, Mass. In this installation, the driving and driven elements can connect at one point in their rotation. However, since the shuttle makes one rotation for each trip across the loom, or two rotations before the shuttle is again at the same end of the loom, it is necessary that the clutch can be engaged only when the shuttle is at the set end.

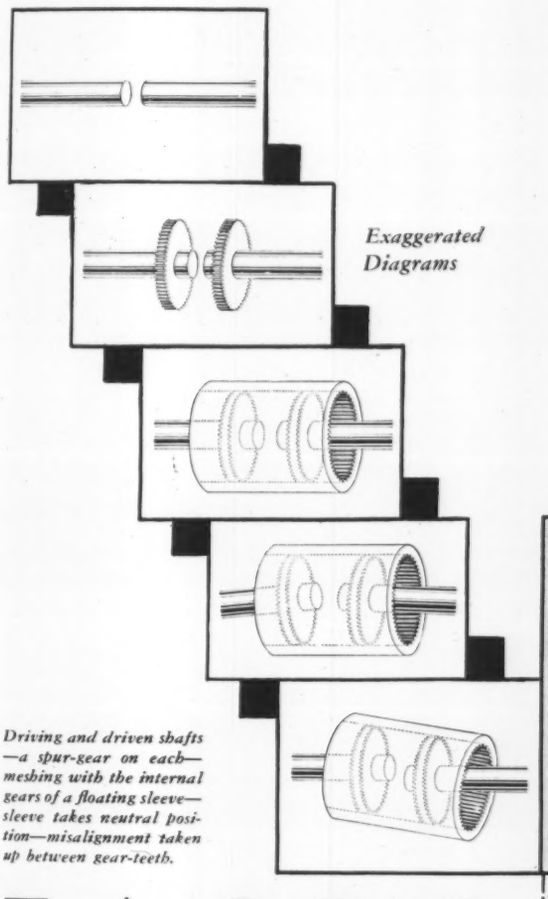
A driving bevel gear which meshes with bevel

Coupling Replacements Banished

-- *no Flexible Pins or Springs*
-- *no Perishable Felt Washers*



Fast's Flexible Coupling installations at the Main Pumping Station of the Pure Van Pipe Line Company, Van, Texas.



Exaggerated Diagrams

Driving and driven shafts —a spur-gear on each— meshing with the internal gears of a floating sleeve— sleeve takes neutral position—misalignment taken up between gear-teeth.

FAST'S MECHANICAL FLEXIBILITY

THE diagrams tell the story. Instead of depending upon flexible materials for flexibility, all forms of shaft misalignment are compensated for between the lubricated faces of the gear teeth.

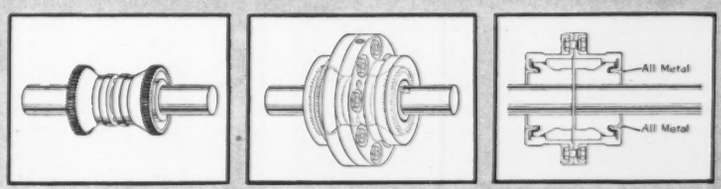
And better still, Fast's Coupling is "double-engagement." Misalignment is divided between two sets of gear teeth, the center sleeve taking a neutral position. *Only* by "double engagement" can *all forms* of misalignment be taken care of without damaging stresses and crank-action in the connected shafts and bearings.

PERMANENTLY DUST PROOF

Oil carries the load between the gear teeth, due to capillary and centrifugal action produced in rotation. And this oil is permanently clean and free from moisture, dust, and grit. All-metal *bearing rings* seal the sleeve. No washers, no makeshifts. Permanent and definite seal makes Fast's Coupling (when oiled like any other equipment) last as long as connected machines.

Fill in and mail the coupon below. It will bring you the new bound catalog of Fast's Self-Aligning Couplings and their application to your problem.

Dust-Proof - - And Stays Dust-Proof



Two hubs carry generated gears. *Internal teeth of sleeve mesh with hub gears.* *All metal bearing-rings permanently exclude dust and grit.*

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gear 11, Fig. 3*A*, constitutes the driving element. Gear 11 rotates freely around an upright shaft 12 and is held against moving downwardly. The driven member 15 of the clutch has a vertical slot 17 which is adapted to certain angular positions of the elements to be in alignment with slot 18 formed in hub 19 of gear 11. Coupling 20 has a tongue 21 which moves in these slots. This member is provided with hub 22 having a groove 23 to receive the fingers of a lifting lever.

After the lifting fingers have raised the coupling, the shaft must be rotated by hand to get the grooves again into alignment so that tongue 21 may return to its original position as shown in cross section in Fig. 3*B*. When the shaft 12 is rotated the controller 32 traveling perpendicularly to the slot, across hub 19 in which it is held by integral lugs, is moved from groove 44 and enters outer groove 43 by engagement with either surface 46 or 47.

After the controller has entered the outer groove, it will remain in angular position with regard to the slot to be under tongue 21 when the latter arrives at the peripheral point on

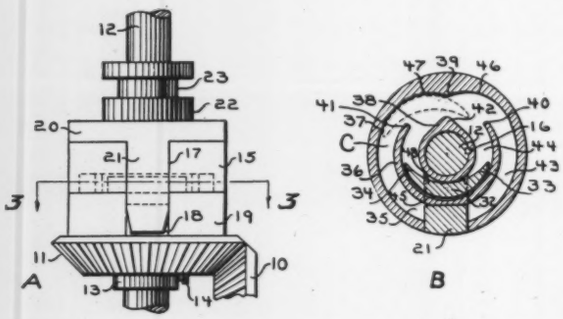


Fig. 3—A—General arrangement of driving mechanism when the tongue is in mesh ready to drive the loom. B—Cross-section of A on line 3-3

hub 19 where the hand rotation of shaft 12 was started. The clutch cannot under these conditions be connected and another revolution of the shaft is required. In doing so the controller will be moved from the outer groove into groove 44 and at the end of the revolution will be in the inner groove or out of vertical alignment with the tongue.

RELATIVE movement between driving and driven elements of a joint, patented by Alfred O. Williams, Battle Creek, Mich., occurs by virtue of the elastic flexing of an interposed rubber connecting member instead of by pivotal movement between connected parts. The patent, number 1,790,516, has been assigned to Clark Tructractor Co., Battle Creek, Mich.

In the joint, Fig. 4, the shafts 11, 11*a* may be regarded as any rotary driving and driven elements. Mounted on these shafts are flanges 12, 12*a* and coupling rings 13, 13*a*.

Interposed between the tapered surfaces of rings 13 is the rubber connecting member 22, which is preferably in the form of a ring. This rubber ring is of tapered cross section with its sides vulcanized directly to the surfaces of coupling rings 13, 13*a*. In order to increase the area of attachment between the two, the surfaces of the coupling rings are formed with annular ridges and grooves 23, the rubber being vulcanized into these serrated surfaces.

Provision may be made for circulating air through the rubber and thereby dissipating any

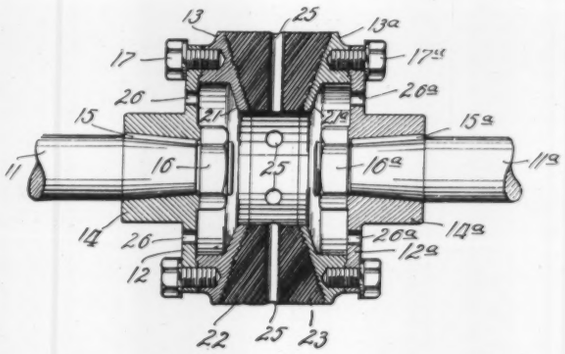


Fig. 4—Interposed rubber connecting member provides joint flexibility

heat which may be set up as a result of the rapid flexing of the ring. It may be molded with cylindrical holes 25 extending from the inner to the outer peripheries at spaced points. The webs of the radial mounting flanges 12, 12*a*, in this construction are provided with spaced air inlet openings 26, 26*a*. Air enters the circular space within the rubber ring through these inlet openings, and thence is whirled outwardly through the air circulating passages 25 by the centrifugal force.

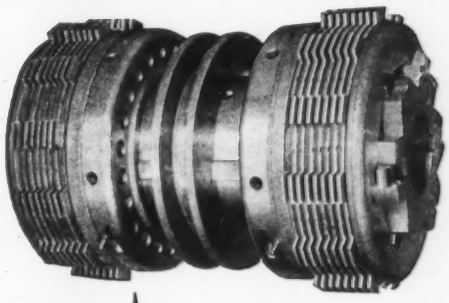
Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

FRICTION CLUTCH—1,790,284. The combination of a clutch release plate, an antifriction button, means on the plate to receive the button and detachable means for securing the button on the plate. Assigned to Borg & Beck Co., Chicago.

TOUGH STABLE-SURFACE ALLOY STEEL—1,790,177. An alloy steel containing carbon from 1 to 4 per cent, chromium from 25 to 35 per cent, nickel from 5 to 15 per cent, silicon from 3½ to 8 per cent and the principal portion of the remainder iron. Assigned to Stoody Co., Whittier, Calif.

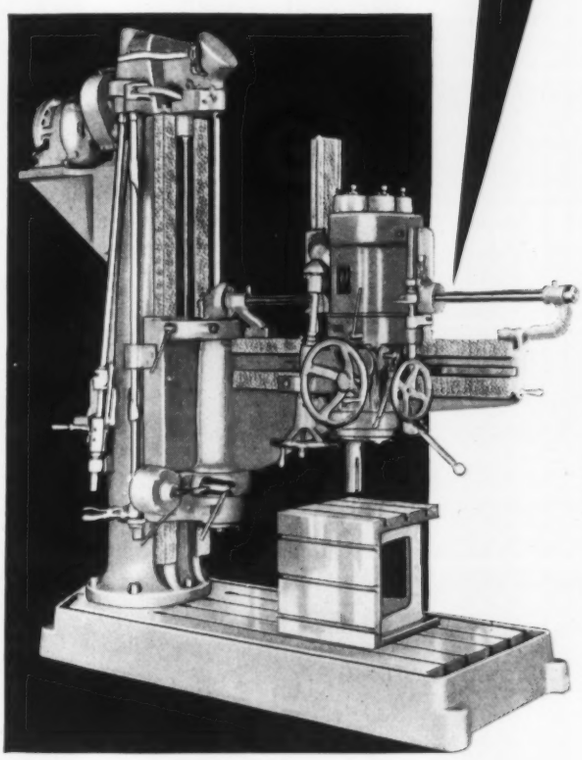
SELF-STARTING MOTOR—1,789,294. The method of operating an induction motor which carries a load at a synchronous speed which causes the motor to operate by the interaction of the primary field with the currents induced in the secondary circuit. Patentee, Edwin C. Ballman, St. Louis.



Duplex Action
Close Coupled Type
Twin Disc Clutch

EASIER CONTROL SPEEDS PRODUCTION

THE operator of a Western Low Hung Drive Radial Drill can concentrate on his work without being distracted by the manipulation of the controls. The entire control is in a single lever. With this Twin Disc Clutch equipped control, operation is remarkably easy . . . insuring speedier and greater production.

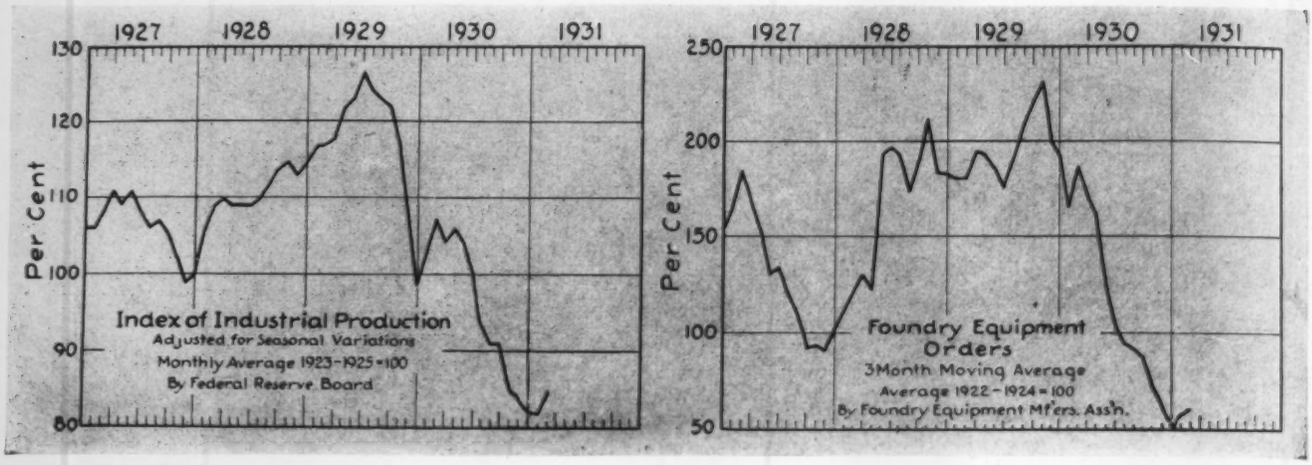


For greater efficiency and less up-keep, the engineers of the Western Machine Tool Works designed this drill with as few parts as possible. It was only natural for them to choose as standard equipment a clutch equally remarkable for its simplicity — the Close Coupled Twin Disc Clutch.

Its hub contains all the operating mechanism . . . centrifugal force operates to release pressure levers. Necessary lubrication is furnished by oil spray. The few adjustments needed are easy to make. Engagement and release are sure and smooth.

Compactness, capacity and all-around adaptability make it the preference of keen designers. There's a size and type for practically every machine tool need—2, 2½, 3, 3½, 4, 4½, 5, 5½, 6, 7 and 9 in. effective diameters; oil or dry plate, single or duplex. Write Engineering Research Dept. for specific recommendations. Engineering Data Book on request. *Twin Disc Clutch Co., 1325 Racine St. Racine, Wis.*

TWIN DISC
CLUTCHES

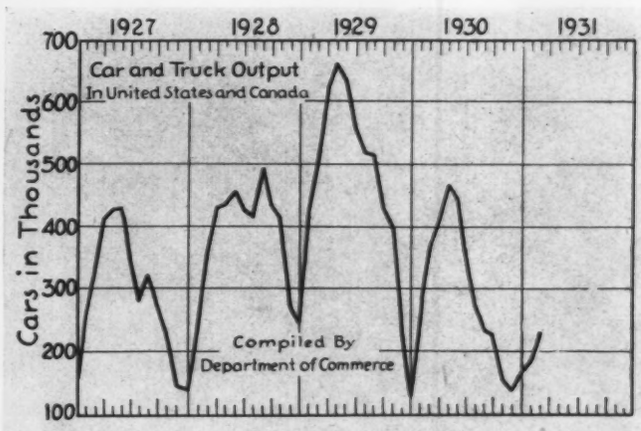


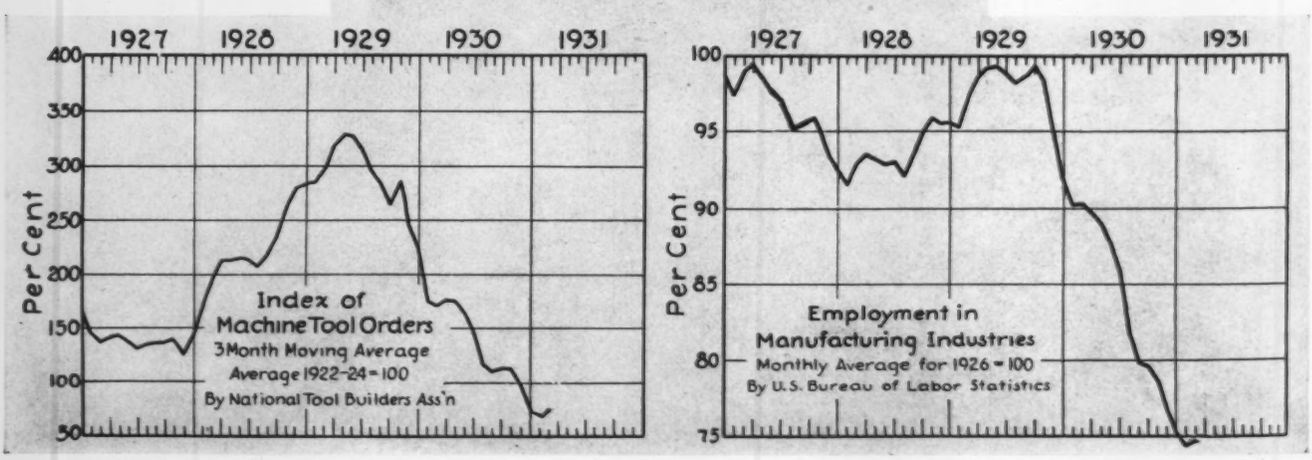
How Is Business?

EMPLOYMENT in manufacturing industries has turned upward! This valuable index, after sinking steadily since September 1929, indicates a trend that now is leading the way in a general recovery of business.

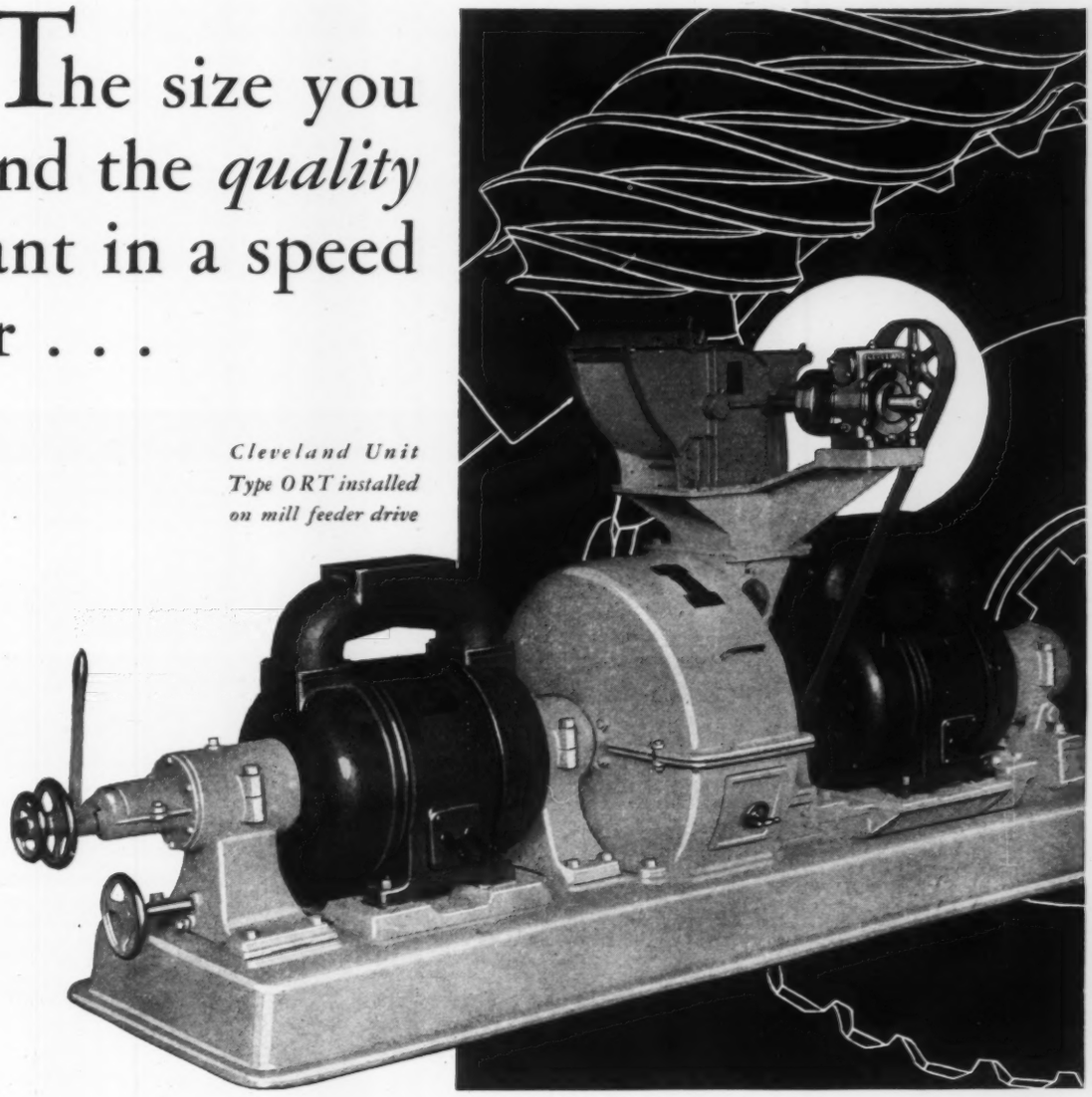
The February figure is only 1.4 per cent greater than the one for January, and is disappointing in comparison with 1930, but it indicates a definite improvement and economists and government experts predict that it will be years before this figure again falls to the low levels endured around the first of 1931. Another indication of a more optimistic attitude is that in all lines of industry studied none reported an appreciable decline while payrolls were increased 4.7 per cent over January. Payrolls in manufacturing industries increased 7.5 per cent. One of the contributors to this improvement is the agricultural implement industry which has shown new life.

Much of the activity at this time may be attributed to the invigorating tonic of the spring business, but during the drab winter months manufacturing companies have been designing and building along new lines while obsolescence has been increasing under the influence of a lethargy in buying. New equipment, new materials and new methods combined with the long overdue replacement business should provide extra stimulus to the seasonal fluctuations. As indexes adjusted for these fluctuations still show improvement over the previous month it is conceivable that this advance is on the point of being expedited.





The size you want and the *quality* you want in a speed reducer . . .



Cleveland Unit Type ORT installed on mill feeder drive

In the "Cleveland" catalog you will find the most complete line of high grade worm gear speed reducers on the market.

There are units for direct connected loads . . . for overhung loads . . . for vertical or horizontal drives . . . for ratios from $3^5/_9$: 1 to 10,000 : 1 . . . for power capacities from 0.2 to 200 h. p. . . . and for speeds up to 4000 r. p. m. Forty-eight standard sizes and types in all, enabling you to select a *standard* unit for any but extraordinary requirements.

Back of "Cleveland" Worm Gear Speed Reducers is a record of years of dependable service on every type of application from electric dish washers to 100-ton cranes. Operating the only plant in the world devoted exclusively to worm gearing, "Cleveland" is equipped and staffed to apply mature experience to any problem involving transmission of power at reduced speed. More than 68% of all "Cleveland" equipment goes to machinery manufacturers.

Cleveland can supply the correct size—and the superior quality—in a hurry. Bulletins 108 and 110 will give you complete data and information.

CLEVELAND
WORM & GEAR COMPANY
3275 EAST 80TH STREET . . . . . CLEVELAND, OHIO
CLEVELAND WORM GEARING . . . THE ULTIMATE DRIVE

Kindly send me Bulletins 108 and 110 containing data and information on your worm gear speed reducers. No obligation.

Name_____ Company Name_____

Address_____

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

THE selection of materials in the design of machines is a subject that should receive long and careful consideration according to W. Trinks, professor of mechanical engineering, Carnegie Institute of Technology, who presented a paper on this subject at the annual meeting of the Steel Founders society in Columbus, March 19. Prof. Trinks stated that "Machines are built up of such a variety of materials that we may well wonder by what steps of reasoning the machine designer is led to select this or that material for a given purpose." The available materials listed, all of which have a definite application, are: iron and steel in all their available forms and alloys; copper, brass, bronze, and copper-lead alloys; aluminum and its alloys; lead and its alloys; copper-tin-antimony alloys; zinc alloys; wood, bakelite, rawhide, fiber, and similar products; asbestos; glass, porcelain, leather, carbon, cork, and rubber; and concrete.

* * *

German Engineers To Celebrate Anniversary

VEREIN DEUTSCHER INGENIEURE, Germany's greatest engineering society, will celebrate the seventy-fifth anniversary of its founding at its seventieth annual meeting at Cologne, Germany, June 26-29. The celebration will open with an exposition on the history of the organization, followed by the unveiling of a memorial to Langen and Otto, the inventors of the gas engine. At the technical sessions papers will be presented on the welding of boilers and pipe lines, education and training of engineers, flow research, steam turbines, mining machinery and aluminum alloys.

* * *

Rapid Progress Made in Electrical Control

ELECTRICAL control has progressed to such a stage that it must be divided as to type in order that sufficient attention may be given to any one phase to develop it adequately. Such was the contention of the speakers at the conference on electrical control in industry recently held at Case School of Applied Science, Cleveland. Progress in this field is extremely rapid with changes in ever increasing numbers. The photoelectric cell has taken its place in design as a unit to be considered especially when no other application will perform the job. However, with all the advances made, and with the many applications cited by which standard control units may be used in various combinations to solve control problems, the conference brought out very definitely the need for a variable speed alternating current motor that could be adjusted to more than four speeds.

* * *

Recommend Extensive Corrosion Tests

OUTDOOR exposure, accelerated corrosion and wear, and acid corrosion tests for electroplated coatings, malleable castings, iron and steel, and alloys was recommended by several committees of the American Society for Testing Materials at the annual group meeting held in Pittsburgh. Other proposals advanced by the committees were the establishment of a tentative specification for higher strength iron conforming to the requirements of the American Railway association, the standardization of alloy steel, and the preparation of a statement of the present day knowledge of the failure of metals under the simultaneous action of repeated loading and corrosion.

* * *

Machinery Exports Are Important

AGRICULTURAL machinery and implements; automobiles, parts and accessories; and electrical machinery and apparatus are among the five most important classifications of exports of the United States according to a recent report of the foreign commerce department of the Chamber of Commerce. These groups represent 3.4, 8.0 and 3.1 per cent respectively of the total of all products exported. Unmanufactured cotton is first, (11.2 per cent), automobiles second, gasolines, naphtha, and other light products third, (7 per cent), agricultural implements fourth, and electrical machinery fifth.

* * *

Air Cylinders Are Standardized

INTERCHANGEABILITY of different makes of air cylinders on the spindles of machine tools without the necessity of changing the adapter or draw rod is provided by the proposed "American Standard for Rotating Air Cylinders and Adapters" compiled recently by the American Society of Mechanical Engineers. This is one of the series of standards for small

OHIO Torque Motors

THE Ohio Torque Motor is so wound that it may exert its full power through either a part of a revolution or through several revolutions and then may be stalled while still exerting full power for various periods, depending upon the winding.

An Ohio Torque Motor built for 10% locked service may have its current on for 10% of the time, that is, six seconds on and 54 seconds off, or other similar cycles. This Motor can be locked across the line for 10 minutes without overheating.

The 25% locked service Motor may have its current on for 15 seconds out of any minute. It may be left locked across the line for 20 minutes at one time without injury to the motor.

The 50% locked service Motor may be on for half of the time provided it is not locked across the line for more than one hour continuously.

The 100% locked service Motor may be left across the line with current on continuously without injury.

The Ohio Torque Motor is today widely used in Elevator Service, to operate brakes, various types of cams and also reversing or accelerating switches or groups of switches. *This Motor is also available under the above conditions for the operation of valves, clamps, feeds and similar devices in connection with mechanism.* It must be remembered that these Motors may be reversed electrically or they can be reversed simply by means of a weight.

Ohio Torque Motors are available for all the various A. C. multiphase currents, D. C. currents and to a limited extent for single phase currents, and for various speeds from 250 r.p.m. to 1750 r.p.m. They are available in sizes from 3 to 64 oz. ft., that is from 3 to 64 oz. pressure at a one foot radius. Such Motors can exert an enormous torque when properly geared.

Our Engineers will gladly discuss with you the application of Torque Motors to your work.

THE OHIO ELECTRIC MFG. CO.

5919 Maurice Avenue CLEVELAND, OHIO

Also manufacturers of a complete line of Standard A.C. and D.C. Motors

tools and machine tool elements which will be followed at a later date by proposals covering the standardization of certain elements of chucks and chuck jaws, and spindle noses and collets. The present proposal is in tentative form and is open to changes and criticism brought out by users.

* * *

Prepare New Treatise on Belt Driving

BELT driving from the standpoint of the trained engineer is treated comprehensively with a wealth of valuable information, mathematical tables and original nomographic charts in "Treatise on Leather Belting," by George B. Haven and George W. Swett.

The 250-page book, published by American Leather Belting association, takes the reader from the first step in leather manufacture to the work required to transform the raw hide into finished belting leather, and describes the different kinds of leather and their proper field of use. Included are notes on the right pulley to use and why; practical rules governing the application of belts to machines; proper use of idlers; short center drives; and many other details. The book is profusely illustrated and adequately thumb-indexed for ready reference. Distribution will be made through the Chicago Belting Co., Chicago, and other companies affiliated with the association.

* * *

New Equipment Spurs Business

THE development of new equipment and parts is regarded as the most potent available neutralizer for the business depression by the majority of 451 leaders in the metal products and machinery industry according to a survey conducted by Sherman Corp., New York, management and sales engineers. New development with its powers of creating new industry is considered the life of business for it is the greatest means of taking up the slack caused by the so-called technological reaction as well as the diminutive of the effects of cyclical and seasonal troughs. The general inference is that ingenuity should be used to the fullest extent, not only to provide new innovations but also to improve old products in order to freshen their appeal and enlarge their utility.

* * *

Design of Motor Mountings Is Important

MUCH of the difficulty in selecting motors for mounting on machine tools may be avoided if greater attention is given to various types of units and the mechanical features already on the market when the tool is designed. This is the contention of H. W. Rogers, industrial engineering department, General Electric Co., in a paper he presented recently.

Among the different mechanical features available are: Standard horizontal two-bearing motor with feet; flange mounted motors wherein the flange is integral with the end shield, modification of which places the flange more nearly the center of the driving end bearing and permits of construction that provides proper ventilation for both open and enclosed motors without changing the machine housing; round frame motors with no feet but otherwise complete; motors consisting of stator and rotor only, the end shields, bearings and shafts to be finished by the tool manufacturer; motors which lack one end shield, both end shields, shaft bearings, etc., or combinations of these features, but electrically standard.

* * *

Plan Materials Handling Exposition

FOLLOWING the trend towards mechanical equipment for practically all types of materials handling, the first National Exposition of Mechanical Handling is to be held Nov. 30-Dec. 5, in Grand Central Palace, New York. Special sections devoted to mechanical handling equipment have been a part of a number of recent expositions while the proposed development interprets a demand for this type of exhibit investigated by the International Exposition Co., New York.

* * *

Determine New Uses for Cast Steel

NEW uses and new applications for cast steel will be the major subject of research by the recently formed development engineering department, Steel Founders Society of America, New York. John J. Baum, an experienced engineer and metallurgist will be in charge. The department will be prepared to extend engineering service and advice to manufacturers who have a problem in the construction of their equipment where cast steel in any form might be considered.

* * *

International Standards Group To Meet

TECHNICAL subjects to be discussed at the meeting of the International Standards association in Copenhagen, Denmark, in May will include aeronautics, drawings, ball bearings, agricultural machinery, rivets, metric screw threads, metric bolts and nuts, fits between cylindrical parts, steel, and iron. A conference also is planned for secretaries of national standardizing bodies. The American Standards association is a member body and will represent the United States.

* * *

Outline Regulations for Welding Contest

MANDATORY regulations and other pertinent information concerning the second arc welding prize competition sponsored by Lincoln Electric Co., Cleveland, is outlined in an 8-page folder prepared recently by the company.

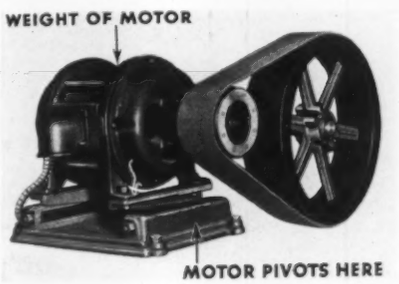
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Drive Maintains Belt Friction

BELT tautness is maintained to the proper degree in a new type of short center drive developed by Rockwood Mfg. Co., Indianapolis, in which the weight of the motor operating on a pivoted base keeps the belt at a constant tension. The accompanying illustration indicates clearly the manner in which this drive operates.

The outfit includes the special pivoted motor base, two pulleys having high coefficient of friction and a special leather belt suitable for use on these pulleys. The motor is mounted on a secondary base which is pivoted to the main base at its front end, leaving the secondary base free to swing. The weight of the motor beyond the fulcrum point serves to counteract centrifugal force which ordinarily causes slipping, particularly in the case of high-speed flat belts.



Proper belt tension is maintained in the short center drive shown

Six standard bases take care of 60-cycle alternating-current motors ranging from 1 to 50 horsepower with speeds up to 1800 revolutions per minute. The base may be mounted on floor, wall or ceiling, to drive a single machine or a line-shaft group. The only restriction for any application is that the driven shaft shall not be lower than the motor shaft.

Case Protects Transmission Units

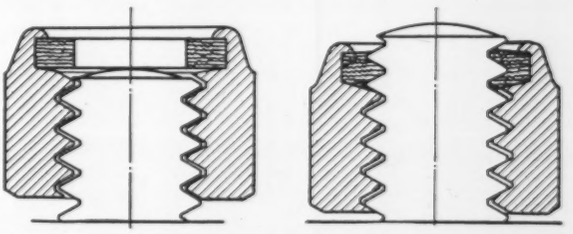
STANDARD internal operating parts of the Reeves variable speed transmission are totally enclosed in a compact, neat, and symmetrical cast iron case in a new design recently brought out by Reeves Pulley Co., Columbus, Ind. The enclosure, shown in an accompanying illustration, meets modern requirements for attractive lines in industrial equipment and is of practical design and sturdy construction. It affords complete protection in all machine applications where the operating parts of the transmission must be guarded from water, live steam, chemical fumes or abrasives.

Compact cast-iron case protects parts of variable speed transmission

Access to the internal operating parts is provided by U-shaped recesses, in the sides of the bottom section of the case, which permit the removal, as a unit, of the operating parts including the bearings of the two shafts as well as the shifting and belt tightening screws. Removal of the lid from the cover section permits minor adjustments, inspection of the internal operating parts, or installation of a new belt.

Safety Nut Eliminates Play

PLAY between thread flanks, found in usual commercial fits, is eliminated in an elastic stop nut manufactured by AGA Co., Elizabeth, N. J., by the insertion of a fiber ring in the top of the nut. The threads in the stop nut are standard in height, form, pitch and fit, and, before the bolt reaches the fiber washer, the stop



Position of fiber ring on safety nut before contact with bolt threads is shown at left. At right, fiber ring is shown as compressed by threads

nut has every property of a standard nut. The only difference between it and a standard nut is that the height is increased to permit insertion of the fiber ring, as shown in the accompanying illustration. The whole assembly is a single unit, ordinary methods being used to attach and remove it.

The hole in the fiber ring is smaller than the outside diameter of the bolt and is not threaded. When the bolt reaches the ring, this ring momentarily resists further movement of the bolt. The bolt tends to push out the ring. In so doing it forces the nut upward until the thread flanks are in contact. This pressure causes friction between the metal threads, which further increases when the nut is drawn home. After this upward pressure has reached its maximum, the bolt enters into the ring, impressing its own threads without cutting out any chips, compressing the fiber material, which closes in around the bolt with an airtight fit.

Controls Sequence of Operations

INDEPENDENT of temperature or pressure, but applicable for use in conjunction with either condition, the new Tycos Tyme-Cycle regulator, announced by Taylor Instrument Companies, Rochester, N. Y., can be used to control the duration of operations in prescribed

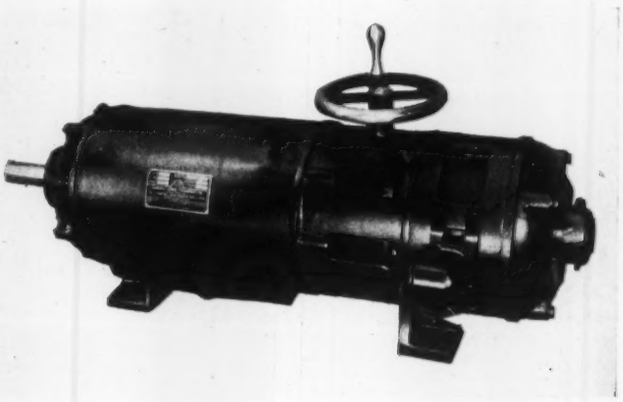
Regulator controls duration of operations in prescribed sequence

sequence, where such operations can be started and stopped by means of an electrical or fluid-operated device. This type of instrument, shown in the accompanying illustration, consists of an electrically driven cam which, as it revolves, progressively opens or closes small pilot valves. These valves regulate the supply of compressed air to diaphragm valves, electro-pneumatic switches or other pneumatically-operated devices as required by the individual application.

The cam of the regulator is mounted on a camshaft which rotates in ball bearings. Steps are cut on this cam according to the number of pilot air valves to be operated. Practically any total revolution of cam can be supplied, and the speed can be increased or decreased to meet new requirements of the process by substituting new cams and gears. This changeover is not difficult to accomplish.

Housing Contains Units of Drive

UNIQUE features characterize the variable-speed drive, which combines motor, speed changer, speed reducer and control in a single housing, recently announced by Stephens-Adamson Mfg. Co., Aurora, Ill. The new drive, shown in the accompanying illustration, is com-



Variable speed drive unit equipped with one horsepower motor

pact, easily mounted, quiet and the maker claims it to be unusually efficient because of the elimination of bearings, couplings and at least two sets of gear reductions. It is made in sizes to deliver from ¼ to 7½ horsepower for driving feeders, assembly conveyors, machine tools, and for other applications where a variable-speed drive is needed.

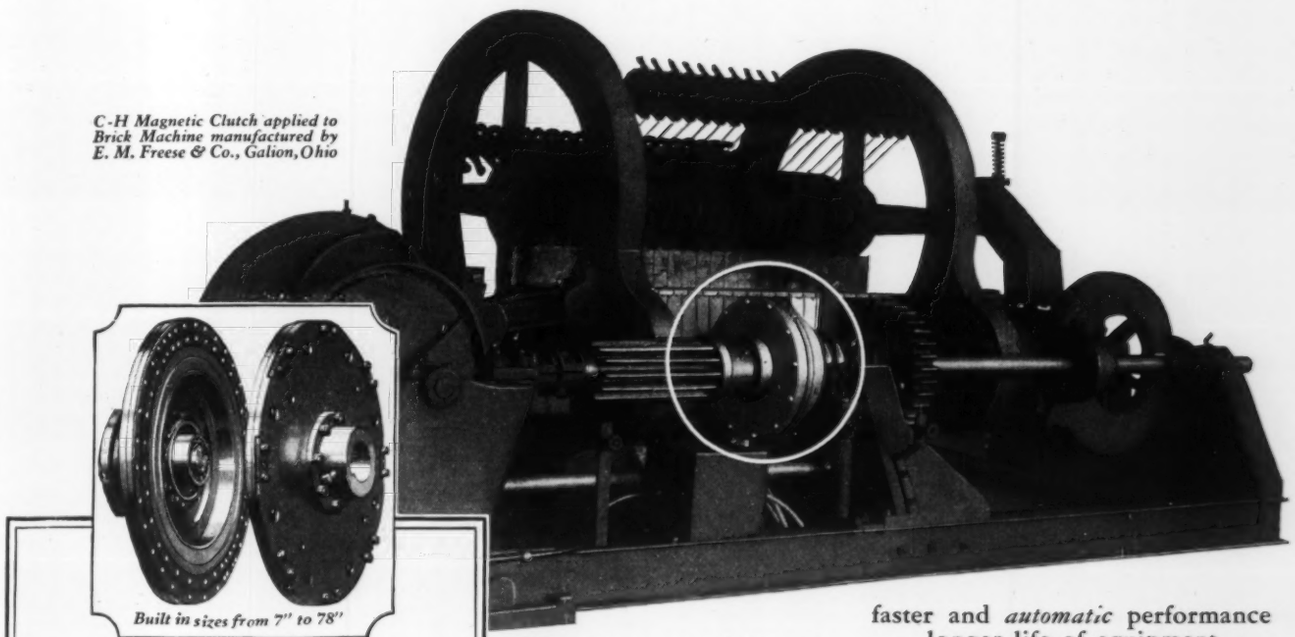
The motor section ordinarily is wound to operate at 1200 revolutions per minute and the drive will deliver the power at any speed between 24 to 144 or 120 to 720 revolutions per minute. The output speed may be increased or decreased while the machine is in motion. The whole mechanism is enclosed in a single housing, and no moving parts, except the output shaft, are exposed. This protects both machine and operators from possible injury. The unit can be mounted in any position by means of four bolts.

Clutch Prevents Reverse Movements

WITH the slightest movement in reverse the Pitter One-Way clutch brought out by Universal Gear Corp., Chicago, automatically locks, preventing any lost motion between driving and driven members. Power applied in the forward direction instantly releases the pressure of the shoes against the inner and outer races

Telling them not to sell on price doesn't solve your salesmen's problem

C-H Magnetic Clutch applied to Brick Machine manufactured by E. M. Freese & Co., Galion, Ohio



Built in sizes from 7" to 78"

C-H Magnetic Clutches Provide New, Effective Sales Advantages

C-H Magnetic Clutches consist simply of two parts . . . neither of which is subject to wear or friction. The armature member "dishes" to engage with the field member. Engagement at full speed is smooth, gradual, automatic; without jerk or jar; easy on motor and equipment. Since there is no end thrust and no heavy back-up parts, there is no strain on the shaft or on the driven member.

Engagement pressure is self-contained! C-H Magnetic Clutches are engaged and disengaged by means of push button or foot pedal located any distance away, or by means of limit, pressure, float switches and the like. Used on your machine they provide advantages which are appreciated by your salesmen and your customers alike.

MOST competitive machines admittedly are too much alike . . . to provoke unusual enthusiasm on the part of the buyer. And it is natural for him, under the circumstances, to be moved by price considerations.

Refusing to let your salesmen meet cut prices is no solution to the salesmen's problem. There is one answer . . . provide your machine with such new and substantial advantages that price becomes secondary.

E. M. Freese & Co. of Galion, Ohio, for example, secured additional advantages for this brick-making machine by using Cutler-Hammer Magnetic Clutches. The machine illustrated above cuts brick to length as the column of clay passes through it . . . by means of wire knives on a large cylinder. The C-H Magnetic Clutch engages and disengages—automatically—15 times a minute, each engagement causing the cutting cylinder to make one-third of a revolution.

Thus are provided smoother, faster and *automatic* performance . . . longer life of equipment . . . maintenance costs cut to the minimum . . . advantages of utmost importance to any buyer and productive of increased sales.

C-H Magnetic Clutches permit remote control by means of push button or foot pedal . . . or automatic operation by means of limit, pressure, vacuum and other switches. Engagement at full speed is smooth, grabless, easy on equipment. Engagement pressure is self-contained . . . eliminating heavy back-up parts, off-center weights, end or side thrust. Each clutch consists simply of two parts, neither of them subject to wear or friction. There are no toggle joints, sliding collars or pivoted arms.

Tested by 25 years of service, C-H Magnetic Clutches today serve over 3 million horse power . . . and their applicability is sufficiently wide to warrant your investigation. Send for booklet CL-1.

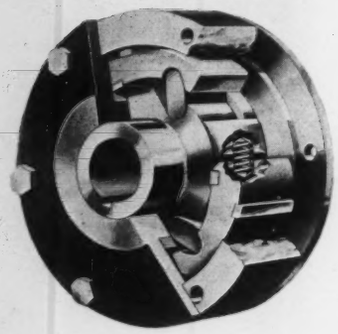
CUTLER-HAMMER, Inc.
Pioneer Manufacturers of Electric Control Apparatus
1326 St. Paul Avenue
MILWAUKEE - WISCONSIN

CUTLER HAMMER

Magnetic Clutches Save Time and Save Equipment

of the clutch, shown in the accompanying illustration, giving a motion which is smooth and instantaneous. No parts can jam.

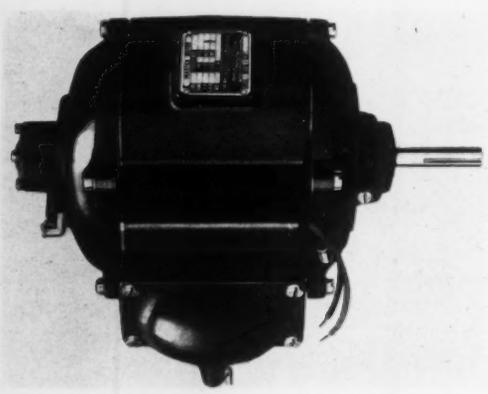
The steel shoes of the clutch have large surfaced steel contact inserts, case hardened and ground for locking with inner and outer races. Both the inner and outer race cases are hardened and ground steel. The steel strut case is also hardened and ground, has large contact areas, and low unit stress. Steel springs in the clutch insure the position of shoe and take up any wear which may occur.



Lost motion between driving and driven members is prevented in this one-way clutch

Integral Switch Protects Motor

COMBINATION of an explosion resisting motor and switch for use in hazardous vapors was recently placed on the market by Master Electric Co., Dayton, O. The switch is built into the motor frame as an integral part of the unit. Combined switch and motor are approved to carry the underwriters' nameplate, assure protection from explosion and completely eliminate the hazard of extra wiring, piping, splicing, etc. It provides a more compact and simplified construction, minimizing the opportunity for service trouble and reducing assembly cost.



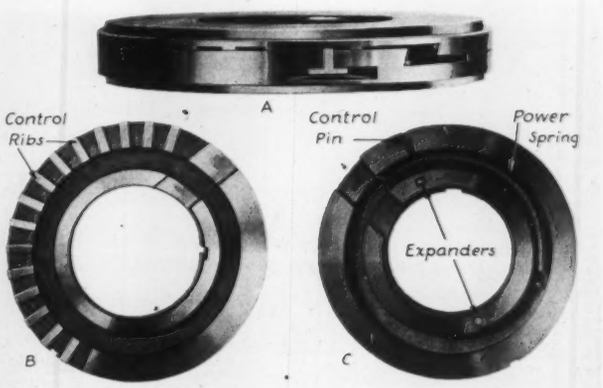
Explosion resisting motor has switch built as integral part

Some of the other features of this combined explosion resisting motor and switch are: Bringing the motor leads out through the motor frame, which permits the removal of both end covers without disturbing the seal; moisture proof construction; quiet operation; high starting torque; large overload capacity, and exceptionally sturdy bearing construction which assures continuous operation.

These units are designed for either horizontal or vertical shaft operation and suitable for use wherever the surrounding atmosphere may be inflammable due to the presence of hazardous vapors. These motors can be purchased in sizes from ⅛ to 1/3 horsepower inclusive, repulsion-induction, polyphase and direct current, all of which are interchangeable as to external dimensions. Widest application is on gasoline dispensing pumps.

Maintains Bearing Clearance

CONSTANT clearance in bearings is maintained by an automatic compensator recently developed by the Wyrick Engineering Co., Wyandotte, Mich. This device, known as the Wyromatic Compensator, eliminates the necessity for manufacturing to some of the close limits now specified as it will correct inaccuracies present in reasonable machining.



Assembled view of automatic compensator for bearing clearance is shown at A. The two mating helical cam-faced parts are B and C

Major parts are two mating helical cam-faced members, Fig. 2, which when placed together as shown in Fig. 1 will increase or decrease their joint cross-sectional dimension if rotated in opposite directions. These two members serve the space-filling requirements which are necessary as wear occurs. The power spring, which is attached to both cams when assembled, provides the power to rotate the cammed members whenever this action is required. Expanders are two hardened steel balls with expansion springs in back urging them outward.

In use, the various members co-act in the

. . . . A SIZE TO SUIT EVERY PURPOSE . . . .

"COMMERCIAL" Ball Bearings are designed to meet all bearing requirements. You can obtain exactly the type and size necessary for any kind of a job . . . . the price, exceedingly moderate.

We also make bearings to meet your own dimensions.
We offer the assistance of our Engineering Department.
We aid in solving your bearing problems with suggestions.
In other words, "COMMERCIALS" mean bearing service.

"COMMERCIAL" Annular Ball Bearings have the three-point contact. Speeds up to 2500 R. P. M. A larger number of balls. Dual radial thrust load — precision, quality, efficiency.

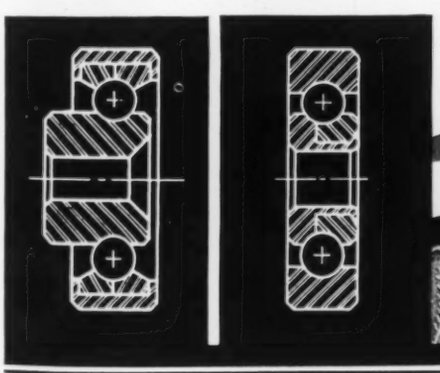
Send for Samples, Quotations and Complete Information.

THE SCHATZ MANUFACTURING CO.
POUGHKEEPSIE NEW YORK

Associated with

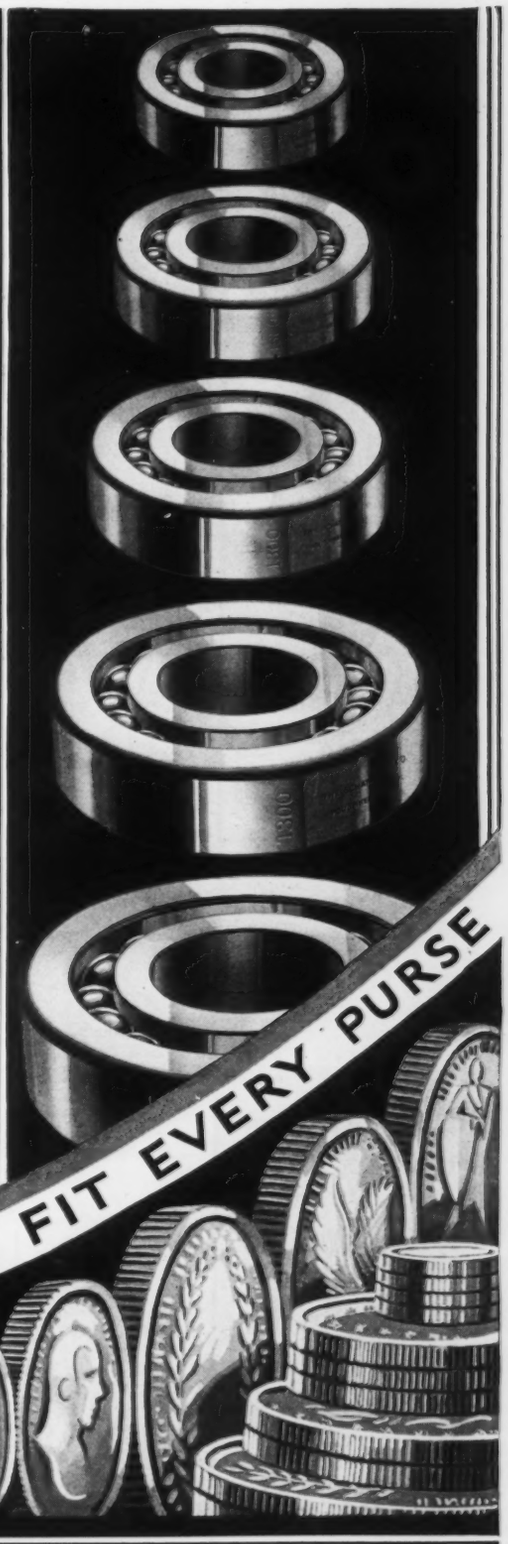
THE FEDERAL BEARINGS CO., Inc., POUGHKEEPSIE, N. Y.
Manufacturers of High Grade Precision Annular Ball Bearings

Two Typical Installations



Detroit Sales Office:
917 Book Bldg.

Chicago Sales Office:
120 N. Peoria St.

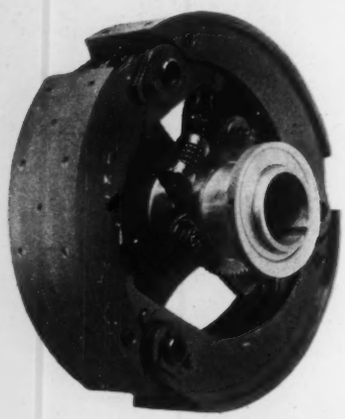


"Commercial"

following manner: Inserted between two spaced parts with the compensator reduced to minimum dimension, the power spring urges opposite rotation of the two cammed members, and such rotational action is restrained by a control rib obstructing passage of the control pin; the expanders continually urge separation of the cam faces and as wear takes place and space is provided the cams gradually separate until the control pin has clearance to pass the obstructing rib. Then the power spring enforces opposite rotation of the cams and this action increases the joint dimension of the cammed members, closing the space between the cam faces, thereby compensating for the increased clearance. The control pin is again obstructed from passing the next rib in the series, and the compensator unit again acts as a mere spacing washer until further wear permits another readjustment cycle.

Provides Low Unit Pressures

LARGE surface contacts resulting in low pressures for every part feature the heavy duty industrial clutch developed by Fawick Mfg. Co., Waukesha, Wis. The clutch, of the balanced expanding shoe type, is shown in an accompanying illustration. The expanding shoes are connected to a system of counterweights which are applied through a 3 to 1 leverage to the toe of the shoe and automatically maintain their effect regardless of wear, making the effort of engagement and disengagement the same under all conditions of load and service.

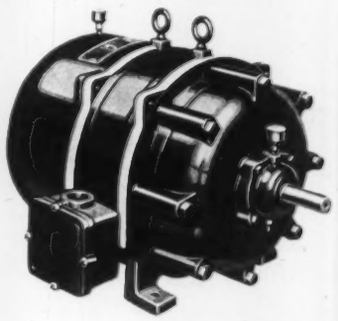


Large surface contacts result in low pressures for parts of industrial clutch

Lightness of rotating parts is secured by the use of steel stampings, hollow steel pivot pins and steel forgings. The pivot pins and shoe borings are large and because of the small travel and low unit pressure, it is said that wear with its accompanying chatter and noise is considerably reduced. The molded asbestos clutch facings, similar to those used for heavy truck and bus brakes, are reported to have shown a possible life equivalent to two million clutch engagements. This is attributed to the large capacity for dissipating heat inherent in this type of clutch, coupled with its light loading pressures.

Approved Motor Is Explosion Proof

APPROVAL of the Underwriters' Laboratories for Class 1, Group D motors has been accorded a new motor recently brought out by Howell Electric Motors Co., Howell, Mich. This classification covers use in gasoline vapor and air mixers or lacquer solvent and air mixture.



Approved motor is suitable for use in dangerous vapors

This motor, shown in the accompanying illustration, is built in either polyphase or single phase design with a totally enclosed frame or a totally enclosed fan cooled frame. The motor illustrated shows the latter model.

The polyphase motors are of squirrel cage construction with extra heavy castings, bolts and parts. All machined parts have large fitting surfaces to correspond with the requirements for the class of service for which they are intended. The single phase motors are of similar construction. These motors are of the condenser start type; each motor having a condenser starting unit placed in a separate box which, according to underwriters' specifications. must be mounted outside the hazardous area.

Floating Spider Transmits Load

ADDITION of the Multiflex spider has increased the range of usefulness of the silent L-R coupling manufactured by Lovejoy Tool Works, Chicago. The freely floating, resilient spider, being the cushion which transmits the load from one coupling flange to the other, is the heart of the coupling, determining its load-carrying capacity under imperfect shaft alignment. The "Improved Multiflex" spider combines a greater load-carrying capacity with an unusual degree of flexibility and resistance to wear. There is no homogeneous material that combines both resilience and resistance to friction wear, so the spider combines two or more

This electric hair dryer is a typical example of G. P. & F. engineering skill in fitting a product to meet new demands. Stamped from aluminum and highly finished, the hair dryer housing is light in weight, neat and beautiful in appearance.

Yours may be different.. *but is it* more intricate?

THE unusual experiences we have had in our 50 years of manufacture of pressed metals have taught us one thing. There is no telling what part of your product can be handled by the stamping process, more satisfactorily, far more economically until you have consulted experienced stamping engineers.

Take, for example, the electric hair dryer case pictured above. Previous to its manufacturer coming to us, there seemed no other way of producing it but by casting. Yet in spite of its intricacy and small size, G. P. & F. Engineers secured the utmost accuracy, the high finish, the light weight, the neat appearance, the beauty, necessary for sales success.

From every angle, be it cost, improvement in design and appearance, or delivery, G. P. & F. can meet your requirements. Send for the booklet, "*In Harmony with Modern Progress,*" and a blueprint or sample for quotation. No charge, no obligation.

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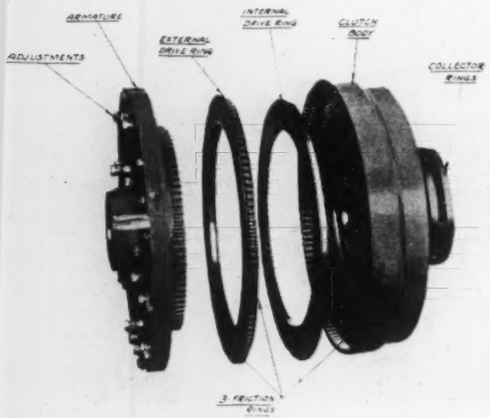
materials, each of which possesses one or more of the qualities demanded, the combination which produces all the qualities required on a definite installation. Thus thin layers of rubber, between layers of fabric, give the resilience required.

Furnishes High Pull-Out Torque

CUMBERSOME bulk, high cost, and difficulty of alignment, disadvantages usually encountered in magnetic clutches have been eliminated by Magnetic Mfg. Co., Milwaukee, in the design of a new multiple disk magnetic clutch. It provides maximum horsepower, greater pull-out torque, ease of operation and smooth acceleration. A typical clutch of the type manufactured by the company is shown in open section in an accompanying illustration. With a 24-inch diameter the company states that over 6500 foot pounds pull-out torque can be developed; ample friction lining being provided for low pressure.

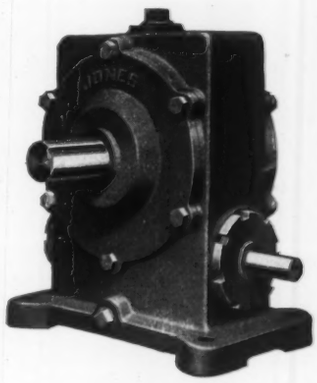


Expanded view of multiple-disc magnetic clutch which provides smooth acceleration

Strength Features Reducers

THREE small worm gear reducers, for small electric motor drives up to seven horsepower capacity, almost identical with the heavy-duty speed reducers, have been developed by W. A. Jones Foundry & Machine Co., Chicago. The worm in this equipment, shown in the accompanying illustration, is made from a low carbon, nickel steel forging that is hardened to increase strength and wearing qualities and to provide a low coefficient of friction. The wheel is made of a special nickel-phosphor-bronze alloy.

Gear blanks of the reducer are dry sand cast and chilled, producing a casting of high strength and load carrying capacity with a minimum of friction. The teeth are generated to a high degree of accuracy by specially designed hobs. A high carbon steel forging is used for the gear shaft which extends out on both sides of the housing so that machines can be driven from right or left hand side or both. A metal cap or shaft guard, easily removed, covers one shaft. Both the gear shaft and the worm shaft are mounted on roller bearings.



Small worm gear reducers are built with alloy steel to provide sufficient strength for heavy service

Design Belts for High Speeds

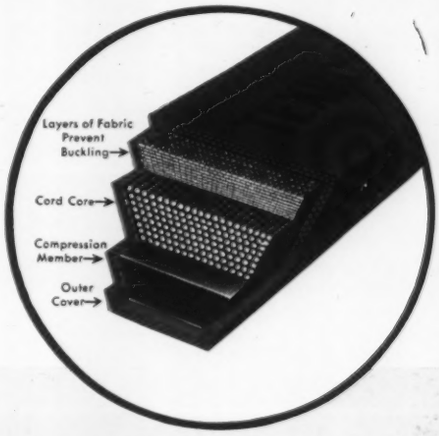
ESPECIALLY designed for high speed small pulley work, the line of "Speedage" endless woven fabric belts manufactured by L. H. Gilmer Co., Tacony, Philadelphia, is furnished in light, medium and heavy weights in a number of different sizes. The belts are built from tubular endless woven fabric by sewing together superimposed folded layers of the fabric. These folds are made in such a way that practically a selvage edge is formed by the strong warp cords. This construction combats the early fraying which is so common to the average fabric belt of open weave construction. Carefully tested and prestretched cotton yarns are used, woven in a special design in such a way that the heavy warps or pulling cords run parallel to the direction of the belt. These warps are held in place by filler cords which occupy very little space but which give an elasticity to the belt structure itself.

Permit Multiple Speed Changes

TWO new switches for use with multi-speed, changeable-pole motors recently was announced by General Electric Co., Schenectady, N. Y. These bear the designations CR-2960-SY-108 and SY-113, the first being for use with smaller and the second, for larger sizes of motors. When used with multispeed, squirrel cage, induction motors, these units permit ob-

No. 3 of a series of data sheets for the use of engineers in applying Texrope Drives to all classes of equipment.

FIVE TEXROPE BELT SECTIONS MEET ALL HORSEPOWER REQUIREMENTS



The horsepower capacities of each size of Texrope Belts have been determined by extensive laboratory tests and many years of actual operation in all kinds of plants under varied conditions.

The horsepower capacities for each belt section, at various speeds, are given here for your guidance. Knowing the total horsepower to be transmitted it is a simple matter to determine the number of belts required. Texrope Belts are made in standard lengths to meet every requirement.

HORSEPOWER PER STRAND OF TEXROPE

Velocity F.P.M.	Section "0"	Section "1"	Section "2"	Section "3"	Section "4"
1000	.9	1.2	3.0	5.5	7.5
2000	1.7	2.3	5.5	10.0	14.0
3000	2.4	3.2	7.5	14.5	19.5
4000	2.8	4.2	9.0	17.5	23.5

It should be remembered that Texrope Belts are built differently from all others. They are scientifically designed for maximum pulling strength, flexibility and ability to maintain their original shape. It is, therefore, unwise to apply Texrope Belt ratings to belts that do not have the strength, flexibility and long life of Texropes.

Each Texrope Belt has a large overload capacity. It is for this reason that Texropes have unusually long life. In fact, many of the original Texrope Belts have been in steady use for as long as five years.

Texrope Drives may be operated with either side the tight side. They are built for reversing service. Idlers are not required. They may be installed as vertical or horizontal drives... easily accommodate slight misalignment... and have an amazing ability to absorb shocks and vibrations.

A sustained efficiency of 98.9% is achieved with Texrope Drives. Their application is universally successful from ½ to 2,000 H. P. for reductions from 1:1 up to 7:1.

Hundreds of manufacturers have found, in Texrope Drives, an effective sales feature . . . Over 100,000 Texropes are now in use. They have effected surprisingly large savings in first cost as well as reduced operating costs.

Send for the Allis-Chalmers Tex-Book and a copy of Bulletin 1228-K, showing over 70 Texrope installations. If you are interested in machine tool applications Bulletin 1236-A will be useful . . .

ALLIS-CHALMERS MANUFACTURING COMPANY — *Texrope Division*
MILWAUKEE *Specialists in Power Machinery Since 1846* WISCONSIN

Atlanta, Ga., Baltimore, Md., Birmingham, Ala., Boston, Mass., Buffalo, N. Y., Charlotte, N. C., Chattanooga, Tenn., Chicago, Ill., Cincinnati, Ohio, Cleveland, Ohio, Dallas, Texas, Denver, Colo., Detroit, Mich., Duluth, Minn., El Paso, Texas, Grand Rapids, Mich., Houston, Texas, Indianapolis, Ind., Jackson, Mich., Kansas City, Mo., Los Angeles, Calif., Milwaukee, Wis., Minneapolis, Minn., New Haven, Conn., New Orleans, La., New York, N. Y., Philadelphia, Pa., Phoenix, Ariz., Pittsburgh, Pa., Portland, Ore., Richmond, Va., St. Louis, Mo., Salt Lake City, Utah, San Antonio, Texas, San Francisco, Calif., Seattle, Wash., Shreveport, La., Spokane, Wash., Tampa, Fla., Toledo, Ohio, Tulsa, Okla., Wilkes-Barre, Pa.

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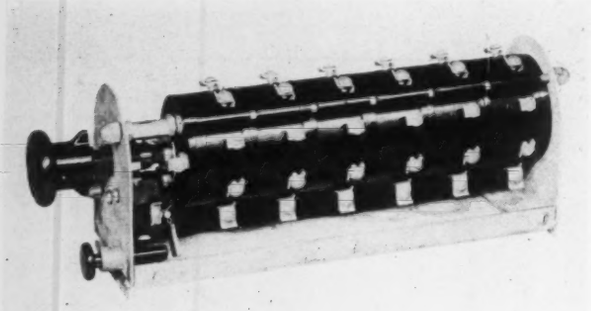
ORIGINATED BY ALLIS-CHALMERS

TEXROPE DRIVES

THE DRIVES THAT REVOLUTIONIZED TRANSMISSION PRACTICE • • •

taining different speeds by changing the polar grouping of the stator coils.

For small motors one of these switches will serve as a starting switch as well as a pole-changing switch. In such cases, some form of under-voltage protection is recommended between speed points, such as is provided by most



Pole-changing switch for use with multi-speed motors shown without case

magnetic starting switches. The new switches can be used with two, three or four-speed motors for constant-horsepower or constant-torque service without change in mechanical construction.

Many Internal Connections Possible

Unit construction is used, making a wide variety of internal connections possible. This construction also makes replacement of individual contact assemblies possible. By removing tie rod spacers and compound space washers, the movable contacts are accessible for replacement without dismantling the switch. In operation the speed point is selected by turning the knob handle to the desired position. Depressing the knob completes the main circuits and then picks up the magnetic line switch through the momentary disc contacts. The holding interlock is then closed and the switch latched in this position.

Pressing the "stop" button trips the holding interlock, dropping out the magnetic switch, and then opens the main contacts. Undervoltage protection is thus provided between speed points. Action is rapid and positive.

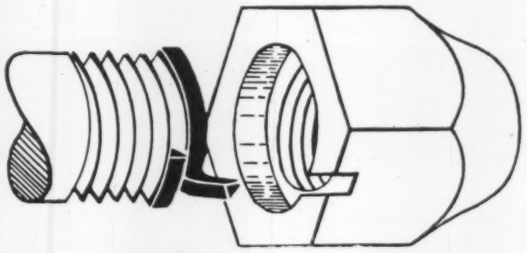
Drawing Board Top Is Unique

A PERMANENT white, smooth drawing surface, resilient, scratch-proof, and washable with soap and water is provided by the "no-ink" drawing board top being marketed by W. H. Long Co., Chicago. The material is obtainable in any size sheets, 1/8-inch in thickness, and can be glued or fastened to old drawing boards. The regular drawing or tracing paper is placed directly on the surface of this board.

All lines are drawn with a double stroke and with a slight pressure on the pencil, 3-H or harder. The pressure of the first stroke ridges the paper, and the back stroke fills the valley evenly with lead. The result is a solid, even-edged line. Changes can be made in any line by the usual rubbing out process. Because of the resiliency of the board, the indentations in the surface made by the pressure of the drawing tools disappears immediately.

New Nut Resists Backing Off

HARNESSING the forces set up by vibration to make them hold the nut in place instead of backing it off, a new lock nut, manufactured by Safety Nut Corp., Philadelphia, successfully resists any effort to shake it off until it is necessary to remove it, at which time it can be taken



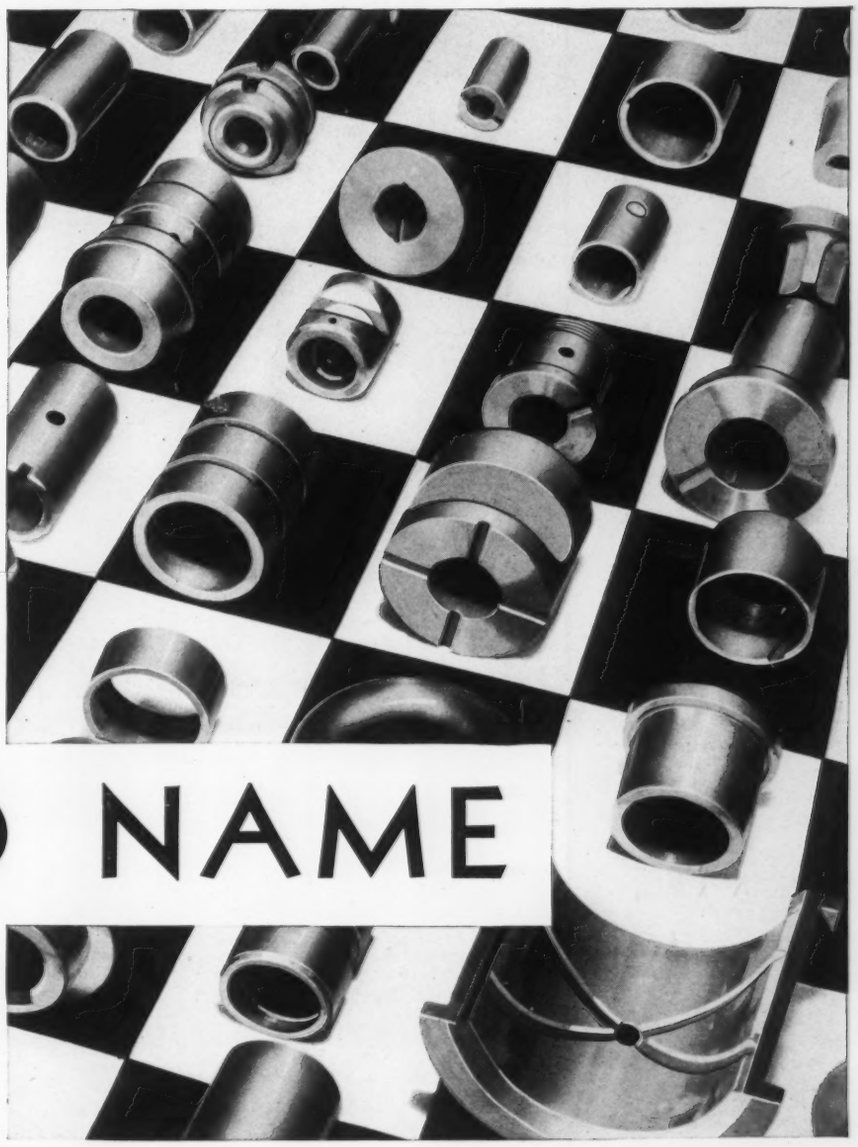
Brake band of lock nut resists backing off by spring action

off with a wrench. As vibration tends to back off the nut, the brake lock band is drawn tighter, thus creating further resistance to the action. The nut with band is shown in an accompanying illustration.

This band is turned on the threads by the action of the nut as it descends. As the nut is turned, the band, cocked in an expanding position, slips on the threads and commences a spiral descent. Just so long as the nut is advanced, progress is easy, but when an effort to withdraw is made, the expanding band of spring steel sets up such resistance that removal can be brought about only with a wrench. The nuts can be made in any desired thread form in any shape, finish, size or material wanted.

Packing Provides Lubrication

ASBESTOS fiber and non-abrasive metal are used in the production of a thoroughly lubricated and graphited packing recently introduced by the Johns-Manville Corp., New York. This packing, shown in the accompanying illustration, is plaited up square from these materials, and is designed for use against steam, air, water, oil, etc., on centrifugal rods



A GOOD NAME *thruout* INDUSTRY

BY STRICT ADHERENCE to the policy, "If a thing is worth doing, it is worth doing well," Johnson Bronze has earned an enviable reputation thruout the length and breadth of industry.

Charting Johnson Bronze progress up thru the past quarter century, it is unmistakably clear that this great name has been made by the consistent delivery of a quality product at fair prices when and exactly as wanted.

Today, Johnson Bronze is regarded everywhere as a specialist in the art of bronze bushing and bearing manufacture, and is thus being privileged to serve an increasingly large number of vehicle and machinery builders and users.

At Johnson Bronze, your bronze bearing problem receives the treatment to which it is entitled—adequate, sensible, and in keeping with modern engineering practice.

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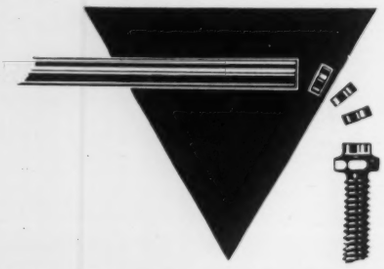
BUSHINGS **BEARINGS** **BAR BRONZE**

RARE METALS AND ALLOYS

FANSTEEL

best source of supply for

Contact Points



"End Grain" Metal

... a feature

IF performance of your product depends wholly or in part on the accurate making and breaking of circuits, type of contacts used warrants most thorough consideration.* Unit cost is small, so only the very best are good enough.

To make sure of supplying only the best, Fansteel employs the more difficult and expensive method of slicing contacts discs from swaged rare metal rods rather than punching them from sheets. Result:—End grain metal, which wears better, meaning longer life, with greater dependability

Fansteel Contact Points made in this manner have proven themselves in a wide variety of electrical applications ranging from automotive ignition and sensitive relays to heavy current carriers in time switches and welding machines.

Send blue print or sample of your product, and tell us the problem. We'll study it, make tests, submit recommendations and estimates; no obligation to you.

* Sometimes specially designed contacts and support members are advisable. Usually suitable contacts may be obtained from Fansteel's large stock of standard types—at a saving.

TANTALUM · TUNGSTEN · MOLYBDENUM · CAESIUM · RUBIDIUM

FANSTEEL PRODUCTS COMPANY, Inc.

NORTH CHICAGO, ILLINOIS

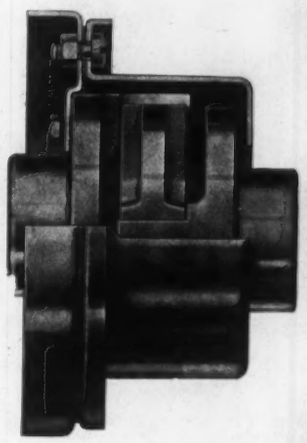
at high or low pressures and at temperatures up to 500 degrees Fahr.

The packing, known as J-M No. 350 Semi-Metallic, can be used either alone or in combination with other rod packings. It is available in coil and ring form in sizes ¼-inch and up. A modified packing, No. 351, is designed for use against gasoline and other cold mineral oils.

Develops Enclosed Type Coupling

GREATER capacity for axial or out of center misalignment is provided by the new Francke cross-type flexible coupling being marketed by Smith & Serrel, Newark, N. J. In both industrial and domestic service small couplings often are called upon to operate much beyond their normal limits. This coupling, shown in an accompanying illustration, is intended for use in just such "careless" drives where it might have to carry more than ordinary degree of misalignment.

Two forged steel flanges with prongs and a light weight center form the principal components of the coupling. A pressed steel enclosing grease case furnishes an adequate reservoir for lubricant and moving parts, providing continuous lubrication. The clearance hole at end of the grease case permits as much as 1/16-inch axial or out of center misalignment and this grease case also acts as a limit stop. A casual check of the coupling which shows the case evenly spaced around the hub indicates that the shafts are in good alignment. For a more accurate check the two flanges can be separated.



Couplings are designed for use where they might have to carry more than ordinary misalignment. The shafts are shown in a relatively out-of-line position

Separation of the flanges also permits packing with grease. For usual installations ordinary cup grease is used.

The coupling is manufactured in four sizes having maximum bores from 1⅛ to 1⅞ inches, and with ratings of 2 to 10 horsepower at 1,150 revolutions per minute, or 3 to 15 horsepower at 1,800 revolutions per minute.

IN the DE LAVAL WORM REDUCTION GEAR, strength is more than mere cast iron and steel; it includes skilled engineering and correct design of wearing surfaces to promote efficiency and durability, proper heat treatment of materials to develop resistance to strain and wear, proper oil circulation for lubrication and heat dissipation, scientific shop control and manufacture to limit gages, with rigid inspection to insure interchangeability of parts, specialized tool equipment for accurate, large scale production, and long experience in the building and application of high grade speed reducers.

DE LAVAL STEAM TURBINE CO. • TRENTON, N. J.

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"SABECO"
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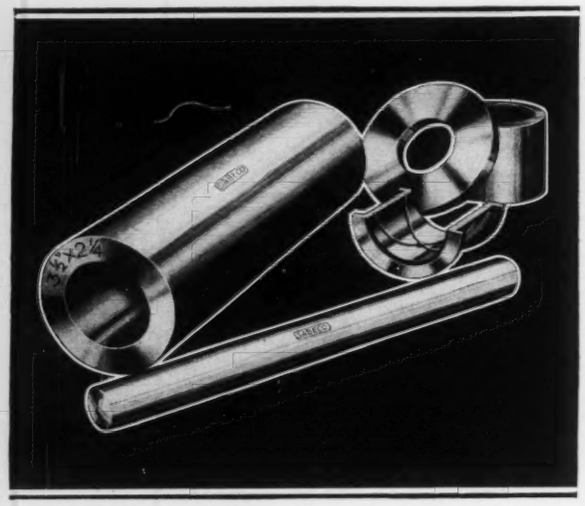

the unusual Bearing Metal

If your machine design calls for bronze bearings that must stand excessive heat, speed, strain, or pounding — use "SABECO".

The special "SABECO" process has taken pure copper, tin, and plenty of lead and produced a metal that for actual service, under any condition, cannot be approached by any other Bronze Bearing Metal.

"SABECO" is made in four grades that will take care of every need.

Write for bulletin which gives detailed information.

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841 S. Water Street, Saginaw, Mich.

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194 Fourth St. Milwaukee, Wis.
634 Slater Bldg., Worcester, Mass.

"Know Your Bearings"

PROFESSIONAL VIEWPOINTS

(*Concluded from Page* 59)

universities?"

The chancellor thought a moment before he answered:

"Young man, I understand that there are some three hundred colleges and universities in the United States. Now suppose that the chancellor, or do they call him the president over there?—suppose the president of each of these three hundred universities should take it into his head to ring me up on the telephone. Why, it would be a damn nuisance, don't you know?"

Not long ago men like this elderly chancellor were the leaders, not merely in education, but in philosophy, in the more or less embryonic sciences, in politics and in economics. To some extent they still are the leaders. It has been difficult, however, for them to adjust themselves to the new order of things; it has been even more difficult for them to cope with the pressing problems that the new order has brought about—problems that cannot be solved on the basis of the classics; and, most of all, it has been difficult for them to admit even to themselves that the real leadership has slipped from their hands, that the forward strides are made by men whom these classicists have held, albeit secretly, in contempt. Hence they pronounce the new innovations as "a damn nuisance," the new order as "a menace."

The changes have been too rapid to allow proper adjustments, and we now are somewhat in the position of a householder who, leaving his windows open, goes out on a leisurely outing. A storm comes up and ruins his curtains and rugs, and it is a nuisance. But who shall say that the rain is not a blessing?

—R. E. FOSTER,
St. Paul

Designing Elliptical Gearing

To the Editor:

IN THE article on the design of elliptical gearing by simple formulas which appeared in the January issue of MACHINE DESIGN, the formula for E could be simplified considerably by factoring as follows:

$$E = \frac{C(R-2\sqrt{R}+1)}{2(R-1)} = \frac{C(\sqrt{R}-1)\ (\sqrt{R}-1)}{2(\sqrt{R}+1)\ (\sqrt{R}-1)} = \frac{C(\sqrt{R}-1)}{2(\sqrt{R}+1)}$$

Then the new formula is:

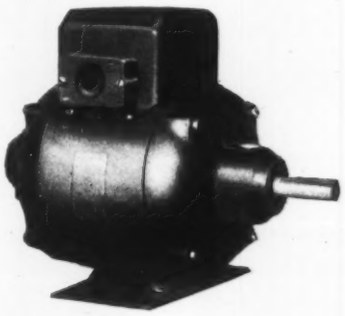
$$E = \frac{C(\sqrt{R}-1)}{2(\sqrt{R}+1)}$$

—CARL A. E. JOHNSON,
Springfield, Mass.

545 Fractional-Horsepower Motor Applications

And . . . .

G. E. builds a type of motor that fits each specific application



THE G-E fractional-horsepower motor is always "modern"; adequate manufacturing facilities, backed by far-sighted research and engineering, keep it always a step ahead. Application engineers will gladly work with you to equip your product with exactly the right motor—either a-c. or d-c. There is a G-E fractional-horsepower motor, electrically correct, and highly efficient, for application to your appliances.

You'll find the story of modern motors extremely interesting; why not ask your nearest G-E office to tell you more about them?

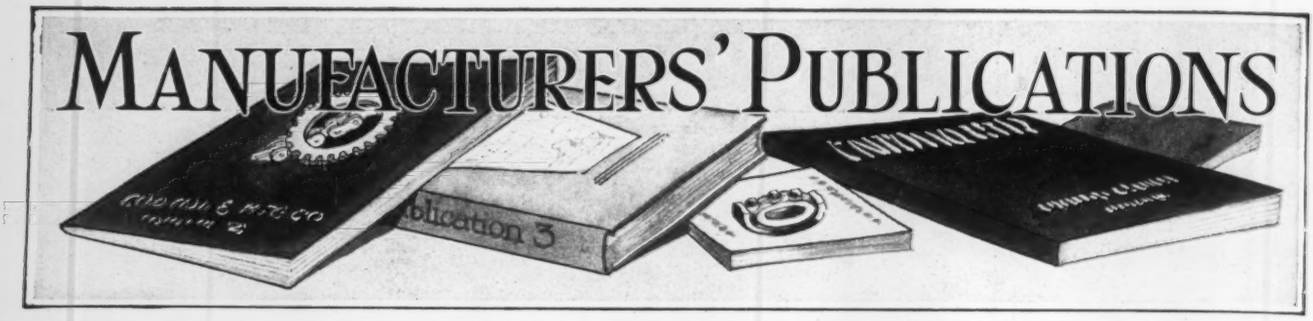
Any standard G-E fractional-horsepower motor built in types BA, KSA, KH, KC, KX, BC, RSA, or K which develops defects in the ordinary course of service may be returned, transportation charges prepaid, to the G-E factory at Fort Wayne, Ind., or to the nearest G-E Service Shop by the original purchaser, his distributors, dealers, agents, within one year from date of manufacture and it will be repaired or replaced free of charge, f.o.b. factory or service shop.

210-123

GENERAL ELECTRIC

SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES

MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

BEARING COMPUTATIONS—Basic formulas, engineering data, computation of loads in spur, bevel, hypoid, helical and worm gear drives, loads on electric motor bearings, automobile bearing loads, and a guide to use for Strom bearings are competently presented in "Ball Bearing Load Computation Manual," prepared by Strom Bearings Co., Chicago.

ARC WELDING—Description of the "Fleetweld" process and tabulation of supplies by the Lincoln Electric Co., Cleveland. Books and papers published by the company are reviewed.

NICKEL SILVER—Riverside Metal Co., Riverside, N. J., has issued an illustrated booklet on the composition, general properties, applications and forms in which the material is available.

EXCITER SETS—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has issued a leaflet, No. 20477, covering its dual-drive exciter sets from 25 to 500-kilowatt capacities. It covers construction of the motor, turbine and generator and describes operation of the unit.

WELDING OF ALUMINUM—Design procedure and methods of fabrication of aluminum and its alloys outlined in *Oxy-Acetylene Tips* for February, issued by Linde Air Products Co., New York.

REGULATORS—Taylor Instrument Companies, Rochester, N. Y., has issued Tycos Bulletin 18,000 containing a complete description of the Tycos Tyme-Cycle Regulator.

COUPLINGS—Performance possibilities, uses and specifications of Francke cross-type flexible couplings are presented by Smith & Serrell, Newark, N. J.

CLUTCHES—Universal Gear Corp., Chicago, has issued a pamphlet on its Pitter "one-way" clutches giving dimensions of clutches carried in stock, and a general description.

SPEED REDUCERS—W. A. Jones Foundry & Machine Co., Chicago, has prepared an illustrated pamphlet, bulletin Forty-one, giving details of design and construction, horsepower ratings, standard dimensions, details of parts and similar data on its line of worm gear speed reducers.

PUMPS—Worthington Pump & Machinery Corp., Harrison, N. J., has issued three booklets giving sizes and capacities, specifications, dimension tables, and drawings of its line of horizontal duplex piston pumps, vertical triplex single-acting power pumps and horizontal duplex hot oil pumps.

ELECTRICAL CONTROLS—Air circuit breakers, oil switches and circuit breakers, air and oil motor starters, and service switches are described in Industrial Control Catalog No. 5016 of the Condit Electrical Mfg. Corp., Boston. The booklet includes convenient tables for calculating sizes required for definite installations.

AUTOMATIC CONTROLS—Brown Instrument Co., Philadelphia, has issued a booklet describing its line of automatic contral mechanisms as applied to a number of leading industries. Both indicating and recording control apparatus are included.

PUMPS—Brown & Sharpe Mfg. Co., Providence, R. I., has issued a circular describing its new rotary geared pumps, No. 53 and No. 55. The pumps are equipped with ball bearings and spiral gears.

COUPLINGS—Dimensions and list prices of the new line of flexible couplings equipped with a L-R Multiflex resilient spider, described by the Lovejoy Tool Works, Chicago.

MOLYBDENUM—Use of this material in cast iron and its specific advantages as applied to alloys for various machine parts is outlined in a booklet prepared by Climax Molybdenum Co., New York.

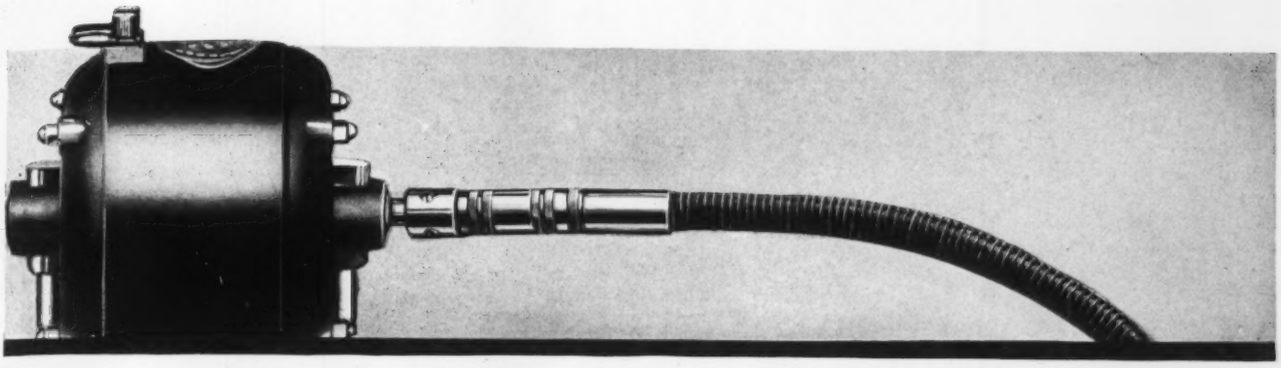
CLUTCHES—Fawick Mfg. Co., Waukesha, Wis., has prepared an illustrated descriptive booklet on its industrial clutch. Claims of the manufacturer on its operation are outlined, and a table gives the capacities of the various sizes.

ARC WELDING—Procedure recommended in the fabrication of stainless alloys by welding, issued in booklet form by Republic Steel Corp., Central Alloy division, Massillon, O. Test results, chemical compositions of alloys, uses and similar data is presented.

AIR-OPERATED CONTROLLER—Bristol Co., Waterbury, Conn., in catalog 4000, describes its air-operated controller equipment, including instrument, valve and accessories sections. Application of this equipment is described and charts and diagrams illuminate the descriptions.

BEARINGS—Fafnir Bearing Co., New Britain, Conn., has prepared the fifth edition of its ball bearing manual and engineering data sheets. Additions to the preceding issue include a section on aircraft bearings and felt seal bearings, as well as a complete new table of limits and tolerances for shaft and housing fits for the company's single and double row types of ball bearings.

ELECTRICAL EQUIPMENT—General Electric Co., Schenectady, N. Y., has issued several catalog inserts as



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Of the many factors that enter into the selection of a portable flexible shaft machine, none is more important than the shaft itself.

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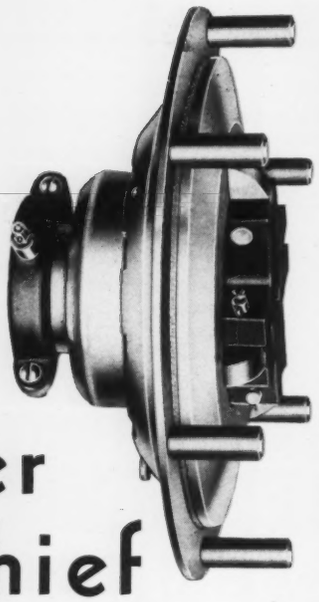

Conquer the Chief

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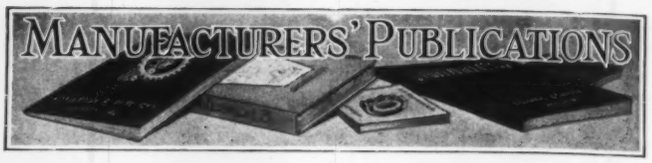

follows: Fractional-horsepower direct-current motors; vertical, hollow-shaft induction motors; helicoil sheath-wire immersion heaters; form IG resistor units; squirrel-cage induction motors, type KG; CR 9504 thrustors; and electric heating equipment for glass-annealing Lehrs.

NICKEL STEEL—International Nickel Co. Inc., New York, continues its series of bulletins on use and applications of nickel steel in industry by presentation in the current issue of 14 product in which this material is used.

CLUTCHES—Data on Peerless unit-adjusting friction clutches with extended sleeves for pulleys is presented in bulletin 571 of T. B. Wood's Sons Co., Chambersburg, Pa.

WIRE ROPES—Hazard Wire Rope Co., Wilkes-Barre, Pa., has issued a circular on its line of wire ropes made from "Korodless" chrome-nickel steel.

PUMPS—Bulletin No. 164 has been issued by the Duriron Co., Dayton, O., on its No. 40 and self-priming No. 50 centrifugal pumps. Descriptions, rating charts and illustrations cover the pumps fully.

EXPANSION BOLTS—Diamond Expansion Bolt Co., Garwood, N. J., presents catalogue 120 which lists the various sizes of Diamond expansion bolts and screw anchors, expansion shields, toggle bolts, and pipe clamps.

ELECTRICAL EQUIPMENT—Crouse-Hinds Co., Syracuse, N. Y., has prepared data sales sheet No. 53 illustrating and describing in detail type CPE fusible Arktite plugs for the individual fusing of portable electrical equipment.

PACKING—Metalastic Inc., Union City, N. J., has issued a booklet on its metal packing which resists corrosion from acids, alkalies, and electrolysis. This packing is claimed to withstand temperatures in excess of 1200 degrees Fahr.

MOTORS—Slip-ring motors are discussed in a bulletin presented by Wagner Electric Corp., St. Louis. The material includes their mechanical and electrical characteristics, the four different types, speed torque characteristics, and control equipment required.

MANUFACTURERS PRODUCTS—American Chain Co., Bridgeport, Conn., has issued a booklet giving a general listing of the products manufactured by the company and others associated with it. The products range over a vast field from tiny sizes of cotter pins to huge iron and steel castings and chains.

RARE METALS—Fansteel Products Co., North Chicago, Ill., has issued a booklet entitled "Rare Metals" outlining the history, properties and uses of tantalum, tungsten, and molybdenum and a booklet, "Romance of Rare Metals," describing the characteristics of tantalum, columbium, molybdenum, caesium, and tungsten.

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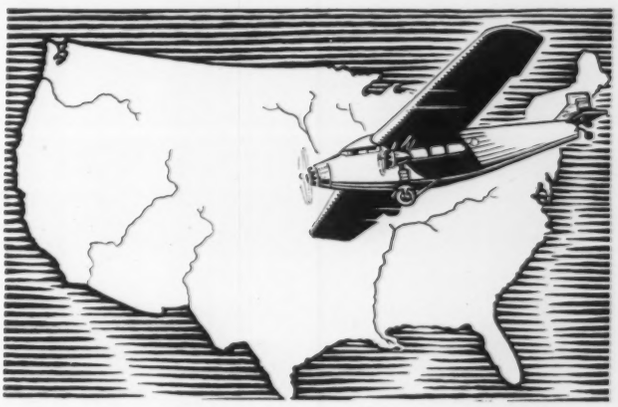


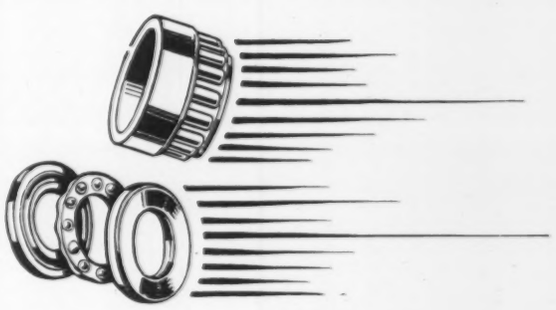
A LARGE automobile manufacturer doubles its production schedule on the spur of the moment. In an instant, 1500 additional bearings—special bearings— are needed urgently if production is not to be held up.

"Call Aetna. They've never failed us yet," says the purchasing department; and at 5:00 P. M. Detroit, talking to Chicago, asks, "How soon can you ship 1500 additional bearings?" "First thing in the morning," replies Aetna. "We'll send a plane for them in the morning," says Detroit.

The bearings leave the Aetna plant in the morning. Willing hands transfer them from truck to plane, for time is precious. They are in Detroit by noon. The production line keeps moving.

Quick work? Yes, of course. But Aetna's strategic location —its unexcelled facilities—and the foresight of an organization that is everlastingly "on its toes," makes such things possible.

Quick delivery is often important and Aetna gives it. But Aetna's guaranteed operation is the real reason why so many users have standardized upon Aetna bearings—lowest ultimate cost with maximum bearing performance. Aetna "makes good" on deliveries and in service.



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